AMERICAN ENGINEER AND RAILROAD JOURNAL.

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CONTENTS.

VALVE MOTION OF RECENT PASSENGER LOCOMOTIVES.

Remarkable Uniformity of Cut-Off.

In describing the new "Central Atlantic" type passenger engines of the New York Central on page 39 of our February number, a table of the valve-setting measurements was presented as taken from one of the engines before it left the Schenectady Locomotive Works. Because of the remarkable uniformity of the cut-off measurements, which are very nearly perfect, the subject was investigated and by permission of the builders of the engines and also of Mr. A. M. Waitt, Superintendent of Motive Power of the road, a diagram of the detail measurements of the valve motion are now presented. These

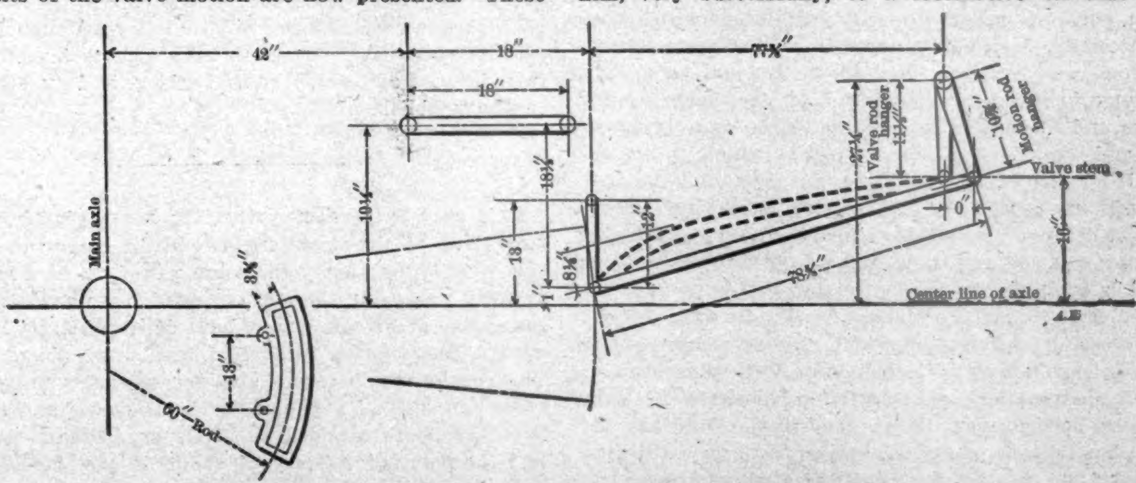


Diagram of Valve Motion—"Central Atlantic" Type Locomotive. New York Central & Hudson R ver Railroad.
(Not to scale.)

dimensions are believed to be sufficient to enable anyone to set up the valve motion on a model for the purpose of investigating the subject for himself.

It is well known to be difficult to obtain such results as these and to get approximately equal valve opening, front and back, at full stroke or up to 15 or 16 ins. cut-off. As a rule the cut-off will not be as uniform as this table shows from full stroke to a cut-off of 6 ins. If equal at 6 ins. it will usually be unequal at full stroke and perhaps be equal at 8 ins. The cut-off at full stroke in this case is longer than many have been able to obtain with a valve motion having 9-32 in. lead and 11-32 in. port opening at 6 ins. cut-off. In order to get this lead and port opening it has usually been considered necessary to provide 1¼ ins. lap and with this amount of lead the port opening and cut-off at full stroke has been decreased. For convenience the table of valve measurements is reproduced as follows:

Valve Motion Characteristics, "Central Atlantic" Type Locomotive. N. Y. C. & H. R. R. R.

No. of Notches.	Lead.		Valve opens.		Cut off.	
	Front stroke. Inches.	Back stroke. Inches.	Front stroke. Inches.	Back stroke. Inches.	Front stroke. Inches.	Back stroke. Inches.
1 Left	0	0	2	2	23	23 1/16
1 Right	0	0	2	2	23 1/16	23⅛
2	⅛	⅛	1¼	1¼	21	21 1/16
3	5/32	5/32	15/16	15/16	19	19
4	3/16	3/16	13/16	13/16	17	17
5	7/32	7/32	⅝	⅝	15	15
6 Left	¼ S	¼ S	17/32	17/32	13	13
6 Right	¼ S	¼ S	17/32	17/32	13	13
7	¼ F	¼ F	7/16	7/16	11	11
8	9/32 S	9/32 S	13/32	13/32	9	9
	9/32	9/32	11/32	11/32	6	6 1/16

The following dimensions may also be convenient here:

Cylinders	21 by 26 ins.
Eccentric throw	5⅝ ins.
Valve travel	6 ins.
Center of cylinder above center of axle	2 ins.
Saddle pin offset	1 in.
Steam lap	1 in.
Exhaust clearance	⅛ in.
Length of main rod	10 ft. 6½ ins.
Admission	Internal
Width of port	1⅝ in.
Motion hangers	Vertical
Radius of link	60 ins.

In looking up the history of this valve motion we find that it originated with Mr. G. R. Henderson, while Mechanical Engineer of the Norfolk & Western Railway. It was applied by him, very successfully, to a locomotive on that road and was developed into the design of the "Northwestern" type locomotives built at Schenectady last year for the Chicago & Northwestern Railway and illustrated in our August number of last year, page 237. Mr. Henderson, until very recently Assistant Superintendent of Motive Power of the Chicago & Northwestern, reports that the valve motion of these engines is very satisfactory, which is substantiated by the following tables of

measurements, also taken before the engine left the works of the builders:

Valve Motion Characteristics, "Northwestern" Type Locomotive. Chicago & Northwestern Railway.

Lead. Inches.		Valve Opening. Inches.		Cut-off. Inches.	
Front.	Back.	Front.	Back.	Front.	Back.
0	0	1¾	1¾	21⅝	21⅝
1/64	1/32	1 11/16	1 11/16	21	21 3/16
3/32	3/32	1 5/16	1 5/16	19	19⅛
⅛	⅛	1 in.	1 in.	17	17 1/16
3/16	3/16	⅝	⅝	13 1/16	[illegible]
7/32	7/32	5/16	5/16	6	6

These records are taken from every engine after the valves are set in the erecting shop. They are more uniform than any we have seen and the motion by which they are produced is worthy of study.

Of late there has been a tendency toward elevating the roundhouse to its proper position as an important factor in efficient locomotive service. The change of operating methods beginning with pooling and including various plans for rapid work at terminals is now appreciated as a most important influence in the economy of the department, and the whole question of locomotive terminals will probably continue to be a vital one. New plans for roundhouses almost invariably include repair facilities, and while this is not a new idea, the inclusion of small shops in the original plans of roundhouse equipment is a sign of the times denoting the necessity for promptness and perfection in running repairs. A better class of roundhouse workmen must also be developed, and it will not be surprising if the most intelligent men of the shop will be needed. It was well said at Saratoga that "any mechanic can tell what is the matter with a driving box if it is out on the floor, but it takes more ability to locate a pound on an engine in the roundhouse and find out which box is going to give trouble." It is the ability to prevent engine failures that is now required in the roundhouse.

It seems probable that the thought now concentrated on metal car construction will eventually produce a satisfactory all metal, or at least a metallic frame, box car. It is a difficult problem and one which, as to the all-steel construction, is not likely to be popular, until the relative costs of steel and wood change materially. It is not so, however, with the steel framing and wooden body, either for box or gondola cars. The time has come for careful consideration of steel underframing for all cars and the extension of steel to the upper framing is natural and logical. This is the direction which progress is taking. All permanent advance comes in steps, and the steel underframe is unquestionably an important step which should not longer be delayed. No one questions the policy of building tender frames of steel, and the reasons are equally forcible as to cars. It is beginning to be appreciated that even with the best wooden construction the repair expenses for sills and end sills are increasing, and not alone with old and small-capacity equipment. It is even more noticeable in modern 30-ton cars, as a result of modern methods of operation in connection with the present heavy locomotives. Steel underframes increase the initial cost, but there is plenty of evidence that they will soon save this cost, and the life of a steel frame when occasionally painted is indefinite. With the adoption of the 36-ft. standard box car, which now seems certain, a very general use of steel underframes may be confidently predicted. This has already reached the drawing-room stage on several exceedingly conservative railroads. With it comes the problem of draft gear, and, on roads having an extensive grain business, that of making the 36-ft. car strong enough, as to frames and trucks, to carry 100,000 lbs. The question of the large capacity is a local one, but that of the steel underframe seems to have general application.

POWDERED FUEL AND SMOKE CONSUMERS IN GERMANY.

Two influences, the high cost of fuel and the necessity for smokelessness, have operated in Germany to increase interest in the burning of powdered fuel. Consul-General Guenther, writing from Frankfort, Germany, says that the high price of coal has made the German manufacturers disposed to listen with favor to proposals to replace their old-style furnaces by apparatus in which low-grade coal and coal dust can be burned and which, through almost complete combustion, are smoke consumers. Because of its clear statement of the principles of pulverized coal burning we are glad to print the following from Mr. Guenther's letter:

"A German imperial commission has been making experiments in the consumption of coal dust in furnaces, and a recent report makes special mention of the 'Schwarzkopff' apparatus (American Engineer and Railroad Journal, December, 1900, page 379). The Journal of the Society of Arts has also given a brief description of the same. It states that it is necessary in the first place to have a highly heated fire chamber for the ignition of the coal dust, for the higher the temperature, the quicker and more perfect will be the combustion. Contact with the boiler walls must be guarded against, as this interferes with ignition; the fire chamber must be lined with fireproof material, as it has to be kept constantly at a certain temperature. It is pointed out that such a fire chamber is not an inconvenience, but rather a special advantage in coal-dust firing, because it insures perfect combustion, a high temperature of the gases at the start, and protection against the formation of 'needle' flames. Also, after firing has ceased—for the night, for instance—the heat stored in the fireproof walls maintains steam pressure longer and steam is more quickly raised in the morning.

"The managers of State institutions have been instructed to do all they can to prevent or to consume the smoke from their fires, and, if necessary, to have smoke-consuming appliances constructed. Municipal authorities have been asked to do the same. It would seem a propitious time for American builders of smoke-consuming devices to appear on the field. I think it can easily be demonstrated that at least some American devices successfully prevent the formation of smoke and make it possible to use low grades of coal, screenings and dust, so that the cost of the plant is covered by the saving in the cost of fuel in two years. It seems to me advisable for our manufacturers of smoke-consuming furnaces to have experts investigate conditions here. I am convinced that a large and lucrative business can be established."

It is only very recently that the gas engine has become a real rival of the steam engine and the best work for both at this time is practically the same. Prof. R. H. Thurston said recently, regarding the efficiencies of these engines, that "the gas engine and steam engine have delivered a net horse-power with a consumption equivalent to about 1 lb. of good coal. The consumption of such fuel for efficiency unity would be about one-fifth of a pound per horse-power and the engines have thus both attained an efficiency, between the coal pile and the point of delivery of about 20 per cent." Looking at each engine, with a view to future progress, it is fair to presume that the gas engine has the greater possibilities. The developments that we can expect to see in the steam engine are the use of higher boiler pressures, which are becoming available with the use of water-tube boilers, and the superheating of the steam. The opportunities to reduce the wastes in a gas engine are many and it is possible that the gas engine will become so improved in the next few years as to put it in many places and for a variety of purposes, in which the steam engine is now the chief prime mover.

Inspection Locomotive—Chicago, Burlington & Quincy Railroad.

The accompanying engraving illustrates a new inspection locomotive built by the Chicago, Burlington & Quincy for the use of its General Manager. This engine is not specially novel, having been modeled after one built by the Baldwin Locomotive Works for the Philadelphia & Reading. It is much more powerful than most inspection engines and is intended to haul one or more business cars when necessary. The engine itself is an old one, rebuilt for this purpose. The boiler differs from others of the same class in having somewhat stronger construction and a straight shell, with the dome located over the firebox and with suspended crown bars. The cab and observation room are of light construction, principally of Oregon fir with an inside finish of quartered oak and a light green head lining. Special care was taken to insulate the observation room from the heat of the boiler and stack and it is said to be quite comfortable. Eight people may be accommodated in the observation room, four in revolving chairs at the sides and four on the elevated platform on top of the boiler. The engine is equipped with a pneumatic sander, pneumatic bell ringer, speed recorder and electric lights, including an electric headlight. The following list gives the principal dimensions:

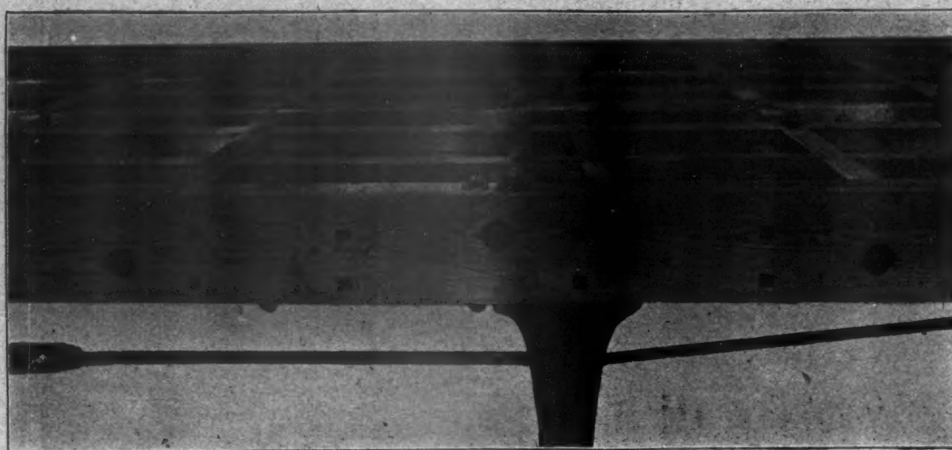
Cylinders	16 ins. by 24 ins.
Diameter of drivers	64 ins.
Weight on drivers	53,300 lbs.
Weight on trucks	32,300 lbs.
Total weight	85,600 lbs.
Boiler pressure	160 lbs.
Diameter of boiler, front course	46¼ ins.
Length of tubes	11 ft. 1 1/16 ins.
Diameter of tubes	1¾ ins.
Tube heating surface	821 sq. ft.
Firebox heating surface	88½ sq. ft.
Total heating surface	909½ sq. ft.
Width of grate	35¼ ins.
Length of grate	66 ins.
Grate area	16.4 sq. ft.
Length of observation room in the clear	14 ft. 1⅛ ins.
Width of observation room in the clear	9 ft.
Seating capacity	8

The manufacture of pinions for street railway motors by the pressing process has been accomplished in Brooklyn. The object is to secure toughness and durability superior to the usual cut gears. Dies are used and pinions are pressed out of cylindrical billets by a 500-ton press. It is stated that by this process a high carbon hard steel may be used. Thus far the process has been applied only to pinions.

The use of steam turbines for the propulsion of the new Clyde passenger steamship now being completed at the Denny shipyard, England, may be expected to lead to some important developments in steamship construction. This turbine vessel will ply between Fairlie, on the Ayrshire coast, and Campbeltown, on the Kintyre coast, a distance of about 40 miles. The character of the journey is such as to thoroughly test this system of propulsion not only for river but open-channel service. The vessel measures 250 ft. in length on the water line, 30 ft. beam and 11 ft. deep. It will be fitted with three separate compound turbines, one high pressure, driving a center shaft with a 4-ft. propeller, and two low-pressure turbines driving two side lines of shafting with propellers 3 ft. in diameter, working a little in advance of the center propeller. The combined power of the turbines is from 3,000 to 4,000 h.p., which is considered ample for the guaranteed speed of 20 knots an hour. A speed of 15 knots is also guaranteed when running astern. To obtain the guaranteed speed in this direction, "astern" turbines are combined with the low-pressure turbines and fitted in the exhaust casting, being permanently connected with the vacuum of the condensers. In going ahead the steam passes from the high-pressure turbine through two self-closing valves to the low-pressure turbines and then to the condensers. To go astern the side propellers are reversed by closing the ahead steam valve and opening the astern valves on each side of the vessel, admitting steam direct from the boilers to the astern turbines. For quick manouvering of the vessel the port or starboard engines can be run ahead or astern independently of each other by closing the regulating valve and two self-closing valves on the high-pressure turbines, and opening the drain valve to the condensers; the high-pressure turbine then runs idly in a vacuum and is entirely out of action. On each of the low-pressure turbines is fitted a valve which admits the steam direct from the boiler to the receivers of the low-pressure and astern turbines. By moving these valves the port or starboard turbines can be run ahead or astern as desired; the entire propelling machinery being operated from a central starting platform. Two Scotch return tubular type boilers, working under induced draft, will furnish steam at a high pressure. Had water-tube boilers been used instead of the Scotch type, the Parsons Marine Steam Turbine Company, who are responsible for the engineering success of the vessel, would have guaranteed a speed of 25-knots instead of 20 knots an hour.

SPLICED SILLS IN LONG PASSENGER CARS.

The splicing of sills of long passenger cars has been practiced for a number of years with apparently no unfavorable results. The subject was introduced by Mr. H. M. Pflieger, Mechanical Superintendent of the Pullman Company, at the recent M. C. B. convention in a topical discussion entitled: "Are there any objections to splicing all sills of long passenger equipment? If not, how should this be done according to the best modern practice?" As a result of the discussion the question will be presented at the convention next year with recommendation. Mr. Pflieger's comments on the practice were as follows:



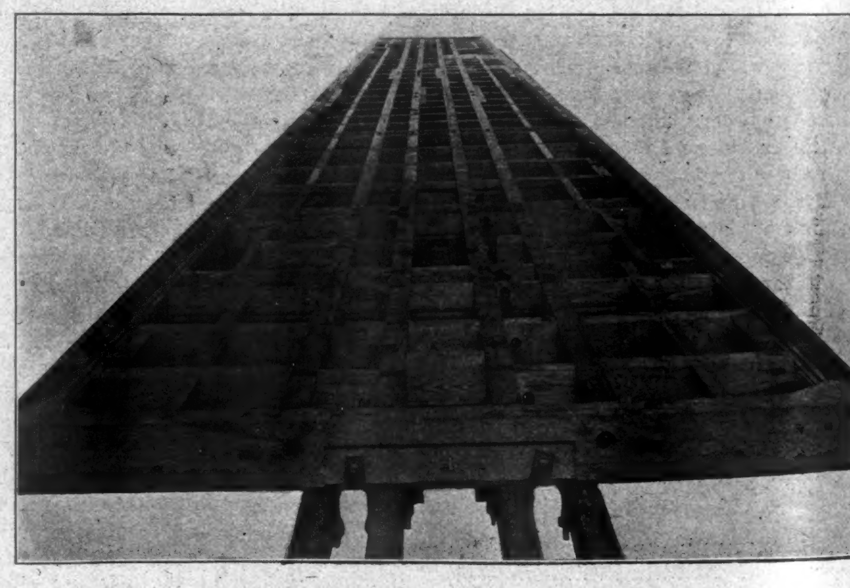
Spliced Passenger Car Sills.

The practice followed by a large number of car builders is to make one splice in the sills of cars 50 ft. and over in length, and this may be taken as a strong indication that there are no objections to splicing sills in long passenger cars; and it may be safely said that if a sill of a passenger car has one splice in it, properly made, it is as strong as a continuous sill. Practice has demonstrated that a properly spliced sill will last as long as a continuous sill, and can be safely used for both side sills and draft sills. The practice of the Pullman Company for the last twenty years has been to make one splice in each of the sills under its cars, and a careful examination of sills which have been in service for many years shows the splice to be in almost as good condition as the day applied, and no indication of having pulled apart or opened. Here is a portion of a sill which has been in continuous service since the car was built at Pullman in September, 1882, and you will note that the splice is in excellent condition after nineteen years' service.

I quote as follows from a letter of Mr. George W. West, Superintendent Motive Power of the New York, Ontario & Western Railway:

"We send you portions of two passenger car sills that have been spliced and in service for sixteen years, and have not had a wrench applied to a bolt or nut used in the splicing. Sills were removed on account of rotten end sills and the tenons on end of draw sills were slightly decayed, and we thought it advisable to remove them; the balance of the sills were as good as the day they were first applied and in as good condition as the section we send you—no indication of either dry or wet rot, and the same condition prevailed throughout the entire sill, except the tenons on the end. The original floor or deafening ceilings have never been disturbed, which is proof positive that the nuts and bolts securing the splices have never been tightened. I take this interest in the matter from the fact that I was associated with the West Shore road when duplicate coaches were furnished that company, and was very strong in my objections to the spliced sills. Experience convinces me that I was wrong in my conclusions, and that the spliced sill, if the work is well done, is fully as strong as the sill without splices. I have watched this matter very closely and have been an advocate in the conventions of allowing sills to be spliced on freight cars, and I assure you that it gives me as much pleasure as it can your company gratification to see these results."

From the foregoing, as well as our own observations, we feel safe in saying that there are no objections to splicing sills in long passenger car equipment, providing the splice is properly made, but on the other hand, there are some advantages in splicing passenger car sills, the chief of which is the better quality of lumber which is obtained in the shorter sills. A car builder can readily obtain first-class sills 40 ft. and under in length, while it is almost impossible to obtain good sills of 60 ft. or over in length. Should sills 60 ft. or over in length be ordered it would be found that delivery was very slow, and the lumber of inferior quality; but, on the other hand, sills of 40 ft. or under in length can be furnished promptly by almost any lumber dealer, and a far better quality of lumber obtained.



Spliced Passenger Car Sills.

It is cheaper to use sills with one splice made of two pieces 40 ft. or under in length, than to purchase a continuous sill about 70 ft. long, as the latter will cost from 40 to 50 per cent. more per thousand feet than the shorter sills. The cost of splicing a sill varies according to the splice made, and will run from $1 to $1.60 per sill. Taking a 70-ft. car, the saving in lumber by the use of spliced sills, as compared with continuous sills, would amount to $39.70 a car—deducting the cost of splicing, $9.60, leaves a net saving per car of $30.10. Should it be granted that there are no objections to splicing sills on passenger cars, the question is: How should it be done according to the best modern practice?

It is our opinion that what is known as a lock splice is the best, the same as is used by a large number of railroad com-

panies in this country, and also in foreign countries, and the same kind of a splice as in the piece of sill here exhibited, and that the length of the splice should be four times the width of the sill and that the splice should be bolted together with two or more bolts. It is advisable to re-enforce the sill on the side with an oak block 2½ ins. wide, depth of sill, and about 6 ft. long, bolting the re-enforcing blocks securely to the sill, as indicated

Spliced Passenger Car Sills.

on blue print here shown. With such a splice the sill is stronger at the point of splice than at any other point, both for resisting a downward load and for cross blow or strain.

In splicing sills it is important that the splice be made over or very close to the center cross-ties or needle beams of the cars, and that the splices be divided over two center cross-ties and the second sill over the other center cross-tie, about 10 ft. away, and the third splice again over first cross-tie—thus alternating the splices of the sills above the cross-tie. In arranging the blocks or strengthening pieces on the sides of the splice of the first sill being over one sill they should be placed on the inside of the outside sill, outside of the intermediate sill and inside of the center sill, so as to counteract each other in any bending moment caused by the car being struck an end blow.

The accompanying engravings were made from photographs exhibited by Mr. Pfleger.

In steam engineering practice of all kinds it is important to know how great a measure of economy can be afforded. If locomotives, marine and stationary engines could be built on a basis of 13 lbs. of steam per indicated horse-power hour in all cases there would be a stupendous saving in the cost of fuel, but economy is often so expensive as to render it advisable to be wasteful and the best engineering skill is required to secure the proper balance in this respect. Students of engineering are apt to overestimate the real value of efficiency and they are often surprised to be told that wasteful operation is sometimes true economy. The high first cost of installation of the most efficient steam machinery for a continuously operating pumping plant is justified, whereas it would be wasteful when applied to a pump operating only a few hours per day. A cut-off of one-quarter stroke may be the most favorable as to coal consumption in a locomotive, whereas the full stroke operation of a heavily loaded engine may lead to greater economy when train and engine crew wages are considered. A quadruple expansion locomotive would undoubtedly be most economical for the operating conditions which would favor its use but who would be willing to recommend the large maintenance expense of such requirements. "How economical can we afford to be?" is an important question requiring experience and sound judgment.

THE NEW SITUATION AS TO FUEL OIL.

Probable Effect on California and Texas Roads.

In 1888 when the Pennsylvania Railroad investigated the subject of oil as fuel for its locomotives, 26,000 bbls. per day—the equivalent in heating value of 8,000 tons of coal per day, the rate of consumption of coal by that road at that time—was nearly one half the daily output of fuel oil of the United States. It was found that with oil at 30 cents per barrel it cost more to take the same train 100 miles by means of oil than by means of coal, but coal was cheap in the Pennsylvania territory. There has never been any question of the steaming qualities of locomotives when fired with oil, and there are no serious practical difficulties but many advantages in oil.

Its use depends upon the relative prices of oil and coal. It is the same question with fuel oil as with corn. When coal is high and corn is cheap it may pay to fit up to burn corn. Our readers will remember the experiments made by the University of Nebraska in 1897, when it was determined that one pound of screened Wyoming coal, costing $6.65 per ton, evaporated 1.9 times as much water in a steam boiler as could be evaporated by one pound of a good grade of yellow corn. With coal at $7.11 per ton it paid to burn corn at 13 cents per bushel and coal at $5.41 was equivalent to corn at 10 cents. It is a matter of price and, with oil, also a matter of supply, which amounts really to the same thing. Of course, it would be absurd to think of burning corn on locomotives because of its bulk, but corn serves admirably as an illustration.

The four "gushers" in the newly developed Texas oil fields introduce a new element into the situation. These, the "Lucas," the "Beatty," the "Higgins" and the "Haywood," are reported to give an output "twice as great as that of all of the wells in Pennsylvania." If these are only the beginnings of Texas oil and if this output continues, the southwestern section of the country is to receive a remarkable benefit, the extent of which is not now to be forseen. As to the qualities of the oil and its adaptability to locomotive use, readers are referred to the statements by Mr. Howard Stillman, Engineer of Tests of the Southern Pacific, which are printed elsewhere in this issue.

Among the railroads now using oil fuel extensively the most prominent are the Atchison, Topeka & Sante Fe and the Southern Pacific. Since the close of the year 1900 coal has been abandoned in favor of oil on all locomotives of the Atchison lines in California. This road, however, is much better situated with respect to coal than the Southern Pacific. The latter line of about 8,000 miles lies almost entirely in the States of California and Texas and very near the oil fields of both. Because of the absence of coal deposits west of the Sierra Nevada Mountains coal is very expensive, averaging $4.03 per ton last year, on the Southern Pacific. As this road used 1,629,459 tons of coal last year, the ultimate possible saving by using oil at present prices may be conservatively estimated at between three and four millions of dollars per year, providing the supply is sufficient. This road paid $6,566,751 for coal last year, which was 30 per cent. of the cost of conducting its transportation. These figures indicate the importance of the new developments in oil for only one road.

If the expectations with reference to the territorial extent of the newly found fields are realized, there may be a revolution in locomotive practice in a large and important section of the country.

The number of locomotives turned out by American builders last year was 3,153, an increase of 680, or 27.5 per cent. over 1899, when the record was also broken.

INTERSTATE COMMERCE COMMISSION REPORT.

Summaries of the thirteenth statistical report of the Interstate Commerce Commission prepared by its statistician show that in the year ending June 30, 1901, the gross earnings of the railroads in the United States covering an operated mileage of 192,556 miles, were $1,487,044,814, being $173,434,696 more than for the preceding fiscal year, or an increase of $717 per mile of line operated.

Passenger revenues increased $2,602,646; from mail, $1,753,463; from express, $1,660,096; miscellaneous passenger, $473,659; freight, $135,519,168; unclassified, $341,556, and miscellaneous freight a decrease of $915,892. Operating expenses aggregated $961,428,511, an increase of $104,459,512, or $423 greater per mile of line. The net earnings were $525,616,303, an increase of $68,975,184, or $294 per mile of line. In dividends, $139,602,514 were declared and paid.

Freight and Passengers.

The number of passengers carried during the year was 576,865,230, an increase of 53,688,722, and the passenger mileage, 16,039,007,217, an increase of 1,447,679,604. The number of tons of freight carried was 1,101,680,238, an increase of 141,916,655, and the ton mileage, 141,599,157,270, an increase of 17,931,900,117.

The average cost of running a train one mile increased nearly 9 cents as compared with 1899, while the percentage of operating expenses to earnings shows a small decrease.

Railroad Mileage.

The total single track railway mileage of the United States on June 30, 1900, was 193,345 miles, an increase during the year of 4,051 miles, which was a greater increase than in any year since 1893.

The aggregate length of railway mileage, including tracks of all kinds, was 259,788 miles. This mileage was controlled by 2,023 railway corporations, of which 1,067 maintained operating accounts, 847 were operated independently and 220 as subsidiary.

Locomotives in Service.

During the year there was an increase of 960 in the number of locomotives in service and of 74,922 in the number of cars, the total number in use at the close of the year being 37,663 and 1,450,838, respectively.

The report shows that for each 100 miles of line 20 locomotives and 753 cars were used; that each passenger locomotive carried 58,488 persons, and that each freight locomotive carried 51,013 tons of freight, all showing an increase as compared with the previous year. During the year the 1,017,653 employees of the railways received $577,264,841 in wages or salaries, representing 60 per cent. of the operating expenses of the roads and 39 per cent. of the gross earnings. Compared with the fiscal year 1895 the amount paid in wages and salaries showed an increase of $131,756,580.

Railroad Accidents.

The total number of casualties to persons on account of railway accidents during the year was 53,185, of which 7,865 were fatalities and of the latter 2,550 were railway employees and 4,346 trespassers. The number of passengers killed was 249, or one passenger for each 2,316,648 carried. One passenger was injured for every 139,740 carried. The casualties, both fatalities and injuries, show a substantial comparative reduction over those of the previous year.

In the thirteen years ended June 30, 1900, 86,277 persons were killed in consequence of railway accidents and 459,027 were injured. The passengers killed numbered 3,485; injured, 37,729; employees killed, 38,340; injured, 361,799; other persons, including trespassers, killed, 54,452, and injured, 69,509.

The Central Railroad Club has been asked by the director-general of the Pan-American Exposition to take charge of the ceremonies of "Railroad Day," which has been designated as September 13. Mr. George W. West, President of that club, has appointed the following committee of arrangements: Mr. James Macbeth, Master Car Builder of the Western Division of the New York Central; Mr. W. H. Marshall, Superintendent of Motive Power of the Lake Shore; Mr. O. P. Letchworth, of the firm of Pratt & Letchworth, and Mr. Pemberton Smith, of the New York Car Wheel Works. The September meeting of the club will be held at the Exposition.

The vast dimensions of the combination of interests comprised under the name of the steel trust surprised everyone. It is a combination of combinations, including ore deposits, railroad and steamship facilities, furnaces and mills, engineering establishments and construction companies, until complete steel frames for buildings or the largest bridges may be delivered and erected without going outside of the circles of the trust for an important link in the chain. This concentration surpasses everything heretofore accomplished in the combination of railroads, but we now have a new factor in the combination, the full meaning and importance of which does not yet appear. Whether the new owners of the Pennsylvania Steel Company are the stockholders or the officers of the Pennsylvania Railroad does not matter. It is certain that this large railroad interest has taken the control of this steel corporation with $50,000,000 capital and immense resources. Evidently the United States Steel Company is not to continue without formidable competition.

A comparison between wool and cotton waste for journal box packing, recorded by Mr. T. H. Symington in a paper before the Western Railway Club, shows that wool is more elastic than cotton in the ratio of 22 to 15. In capillarity cotton was superior to wool in the ratio of 131 to 88, and in the height to which the oil was carried by capillarity the cotton was better by the ratio of 1.72 to 1.28. In absorption and in degree and height of capillarity the cotton waste was superior, but the expansion and elasticity of the wool are important enough to lend to its use in many cases, even at a much greater expense. The trouble with cheap waste is that it disintegrates in the boxes on account of its short fiber and shoddy material. The long fiber wool does not go to pieces but retains its form and elasticity. Mr. Symington believes that if cotton waste is held mechanically up to the journal, independently of its own elasticity, and is also held in the box so that it cannot roll up in knots, it would be as efficient packing as wool, and as the cost of the cotton is so very much less than the wool, this would seem to open a field for a large saving in the operation of cars.

Improvements in shop and roundhouse ventilation have been very marked during the past few years, and it is now considered essential to spend a great deal of money in order to insure pure air at the proper temperature where "workmen" are employed. The contrast, however, between the careful treatment of this problem in shops and in drawing rooms is often striking to one who makes a practice of visiting both places. Without the least disparagement of the practice in other buildings attention should be directed to the fact that draftsmen also may be expected to do their work correspondingly cheaper in the proper atmosphere. In one case we recently found eight draftsmen working in a room about 20 by 30 feet in size, with the windows all at one side, and so arranged that no ventilation could be had without inconveniencing the men near the windows. There is no doubt that the work of that department cost from 10 to 20 per cent. more than if it were done in a properly ventilated room. At least from $4 to $5 could have been saved each day in the season of poorest ventilation by the expenditure of a very small sum for devices which would secure a sufficient amount of pure air. It might be accomplished in the case mentioned by the construction of an air duct in which one or two gas jets would furnish the necessary circulation, and the total cost of operation would be that of the gas consumed. There are other methods equally simple. The writer speaks with authority on this subject and sympathizes with the draughtsman who is obliged to endanger his health and his eyesight by working under improper conditions.

CORRESPONDENCE.

TONNAGE RATING OF LOCOMOTIVES.

To the Editor:

I hesitate to criticise the work of a gentleman of Mr. Henderson's acknowledged high standing, but if you care to have some points showing omissions which Mr. Henderson has made in his proposed system of tonnage rating (Mr. Henderson's paper appears almost in full in this issue.—Editor) which are essential to its success I would be glad to give you the data, but I would not like to stand in the position of criticising his work, because, as far as he has gone, his ideas are very good indeed. He has gone over the same ground that we passed over when we began to study the question of tonnage rating. The practical application of the system, however, suggests some vital points to which he makes no reference.

For instance: On a 10-hour and 50-minute schedule for 170 miles, an exceptionally long run, the time required for stops will vary from 1 hour and 30 minutes to 4 hours and 30 minutes, according to the number of trains in each direction, the length of sidings, the distance between sidings, the facilities for coaling and watering engines and the methods of handling trains on the run; hence, in calculating the load that can be taken, you must first determine by a check of the service just what time is required for stops per mile on each freight run.

As I understand Mr. Henderson, he bases his rating entirely on the limiting portion of the run. For example: If it should be a 1 per cent. grade the calculation would show that for each 1,000 lbs. of locomotive traction a load of 80 Ms. could be taken at 10 miles an hour. If it were desired to make 20 miles an hour this load would be reduced to about 60 Ms. for each unit of engine traction. This is a 25 per cent. reduction in the load to make the faster speed. While this reasoning will apply to the limiting portion of the run the same calculation applied to the entire run instead of to the limiting portion only, viz., by making a virtual profile, as suggested by Mr. Henderson, modifying the actual profile; plotting velocity heads at different points along the track and joining these velocity heads by lines that will measure the grades, the resistance from which will equal the power consumed or required by change of speed or elevation, from one terminal to the other in both directions on the run, you have data from which to make a table to show the load that can be taken at different speeds, for each section of track between every two stations in each direction. From this table a time-line can be made for a train showing the number of minutes required and the speed in miles per hour that can be made with a given load.

The value of this system may be understood by citing the above 170-mile run. Competitive traffic conditions might require two hours faster time to be made on this run, and the practice shows that 8 hours and 30 minutes out of the 10 hours and 50 minutes card time are required for running time. This would reduce the actual running time from 8 hours and 30 minutes to 6 hours and 30 minutes and would increase the average speed over the entire run from 20.3 to 26.2 miles per hour. Suppose the practice shows that 120 Ms. of load for each unit of engine traction can be taken at a speed of 20.2 miles an hour in regular daily service. Now the question arises, how many Ms of load for each unit of engine traction can be taken at an average speed of 26 miles per hour over the whole length of the run, not over the limiting portion, as it does not make so much difference what speed is made over the limiting portion of the run. By reference to the table already prepared, as outlined above, a time-line can be run in 20 minutes showing the number of Ms of load that can be taken over the run in question in 6 hours and 30 minutes instead of 8 hours and 30 minutes, thereby giving the most economical load that can be taken within the prescribed time for the whole distance.

It is also necessary to make some check of the performance in order to determine what resistance formula will meet the requirements of the road for which the engine rating is to be made. The "Engineering News" formula and the Baldwin Locomotive Works formula referred to by Mr. Henderson were deduced from experiments on heavy rail on some of the best track in the world, and this high standard of excellence in track conditions is not to be found on most of the roads of this country. Our practice also shows that for rating purposes the cylinder traction of locomotives on heavy grade lines should be limited to about 22.5 per cent. and for valley lines 25 per cent. of the driver weight.

From the foregoing you will see that there are many practical factors to be considered in formulating a system of tonnage rating, and while the principles laid down by Mr. Henderson are correct in theory, they cannot be applied to make a successful system of tonnage rating without considering the other elements which come into the practice, as suggested above, the most important of which is the determination of the speed that can be made with a given load between every two stations from one end of the road to the other, which is really the essence of a successful system, as it is only by this means that we can arrive at the load that can be taken within the prescribed time limit with the greatest degree of economy.

B. A. Worthington,
In Charge of Tonnage Rating,
Southern Pacific Company.

POSITION OF AN AIR-BRAKE INSPECTOR.

To the Editor:

The extensive use of the air brake on locomotives and cars demands of every well-managed railroad a superior man for this particular responsibility. He is one whose knowledge and worth should be considered and respected by those whose duties are in any way connected with the handling of trains or who superintends the application and care of such equipment. The man appointed to the position of chief air-brake inspector should possess that practical part of railroading which will enable him to use the judgment and tact necessary to accomplish the best results. He should be schooled especially in the mechanical department that his knowledge of the use of the apparatus may not be questioned. Of course, his judgment or recommendation may be criticised similar to those of other officials, but having a clear understanding of this line of work an immediate tendency will be to harmonize many of the complicated and unsettled questions in his sphere.

It is frequently stated that the interests of the air brake are only allied with those more directly concerned in its care and operation, but the rapid growth of this faithful agent for fast and heavy trains has increased its importance. Our own, as well as other Governments, recognize this, and it is, therefore, of considerable consequence that the brake apparatus and its interests be closely followed by a competent person.

By way of a practical illustration, a certain division on a railway, which is not unlike many others topographically, is responsible for a large number of slid flat wheels under cars having air-brake equipment. A freight train leaving a division point has fifty cars in good condition, thirty of which on the head end have air brakes in working order. On arriving at the terminal the tenth car from the locomotive is found to have under it three pairs of slid flat wheels necessitating removal. To ascertain the cause of this difficulty the Division Superintendent does all within his power. He patiently listens, and from reports forms certain conclusions, the substance of which leaves the matter imperfectly settled, with him at least, without satisfaction. The attention of the General Superintendent is called to the wheel sliding on this particular division, and he requests of the air-brake inspector that an investigation be made for the cause of the removal of so large a number of wheels, and at the same time expresses surprise at the unnecessary expense and trouble chargeable to air.

Now one phase of the duties of the air-brake inspector and those directly under him is to determine the real cause for flattening these wheels. The trouble may be complicated, but with the proper understanding and treatment these causes for such complaints will at once grow less. This, however, involves keeping the proper remedy in stock, which is a competent person to look after the varied interests of the air brake in its application to rolling stock and maintenance, one whose position is respected by official and employe.

It is necessary that an individual be sought for special adoption in his particular line, if he will be the most proficient for a special calling. Many opinions in a matter of moment may be ventured by those whose daily duties and experience entitle them to much consideration, but guess work is not an increasing quantity in the market of the railroad world to-day, nor is it allied to the successful operation of any business.

New England.

MAKING ERASURES ON TRACINGS.

"The most successful plan that I know of for making erasures on tracings and then obliterating the effects of the erasure, is first to use an ink eraser—taking out the lines thoroughly—and then rubbing the tracing with powdered pumice stone. For this I use a piece of chamois skin, first sprinkling the cloth with the powdered stone and then rubbing thoroughly with the skin—afterwards blowing off the stone and polishing with the skin alone. I enclose a piece of cloth from which erasures have been made and which has then been treated in this way."

This paragraph was contributed by Mr. C. A. Terry, to a recent number of the "American Machinist." The editor says that Mr. Terry's results are better than anything of the kind he has ever seen. The gloss of the cloth is renewed so perfectly that only by the sharpest scrutiny can the fact that an erasure has been made be detected. It would pass ordinary inspection without the erasure being noticed.

In the selection of Mr. Potter as General Manager of the Baltimore & Ohio, Mr. Delano as General Manager of the Burlington, Mr. Morse as Third Vice-President of the Grand Trunk and Mr. H. D. Miles—formerly Signal Engineer—as Assistant Superintendent on the Michigan Central, there is a most important indication of the breaking down of traditions. These are instances of recognition of ability which should encourage all in the hope of ultimately reaching the highest position for which their life work fits them. These selections may even indicate an awakening to the need of improved methods of developing men. A thoughtful observer of the situation will be inclined to think that they do and will undoubtedly agree with us in believing that there never was a better time than the present in which to prepare for the rewards of those who can successfully manage the departments of our railroads. In the case of Mr. Miles we have an example showing that to be a thoroughly successful Signal Engineer one must have or acquire the qualifications of an operating officer. The apprentice, the draftsman and even the clerk should take courage for the present tendency toward improved business methods of railroad operation will create a greater demand for well qualified men and traditions are unquestionably breaking down.

Experiments in making coke from Western coals are being conducted at the works of the Illinois Steel Company, in Chicago. While no definite results have been announced, we are informed that the outlook is promising. If successful this will become a most important factor in steel making, which will tend toward a movement of the steel making center toward the West.

NEW LOCOMOTIVE WATER SERVICE.

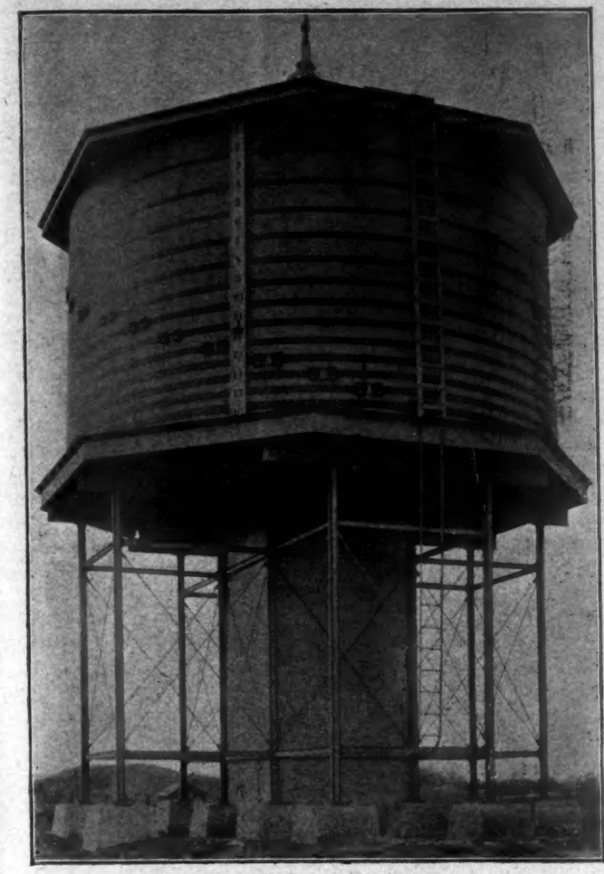
Delivering 5,000 Gallons Per Minute.

Chicago & Alton Railroad.

A number of new water tanks and cranes have been put into service on the Chicago & Alton Railroad in connection with extensive road improvements. One of these stations and one of the tanks are illustrated from photographs received from Mr. T. W. Snow, Manager of the railway department of the Otto Gas Engine Works, the contractors for this work. This represents the best development in this direction and it is important to note that owing to the large pipes and columns 5,000 gals. of water are delivered to a tender tank in one minute. To use such capacity successfully a new valve for controlling the flow at the crane has been developed and it is an essential feature of the system. The standpipes or cranes are 12 ins. in diameter, connected with the tank by a 14-in. pipe. The cranes are 600 ft. apart and the distance from the tank to the further crane is 900 ft. The pump-house is 100 ft. from the tank. These tanks are 30 ft. in diameter by 18 ft. high at the staves, holding 90,000 gals. The posts are usually 20 ft. high and supported on concrete foundations. The posts are made by bending the webs of 7-in. I-beams and riveting the central portions together, making a stiff, strong column. All the new tanks have slate roofs. In the pump-house is a 10-h.p. Otto gasoline engine direct connected to a triplex-geared pump having a capacity of 10,000 gals. per hour. The engines have electric ignition and are automatically controlled. Mr. Snow gives us the remarkable figure of one-half cent per 1,000 gals. of water pumped as the cost of fuel and lubricating oil for one of these new stations. There is no additional cost for operation because the attendance does not necessitate additional expense. Special attention is directed to the importance of the low cost of pumping and also to that of the very rapid rate of delivery of the water. The taking of water is usually the slowest operation about a train stop and under present conditions it is necessary for well understood reasons to save time in every possible way. On a long fast run if the fireman can be quickly released from attending to the water and be given a minute or two to attend to his fire and his coal an important saving would be made and the influence of changing the taking of water from the slowest to the quickest station operation would be great, though impossible to estimate in figures.

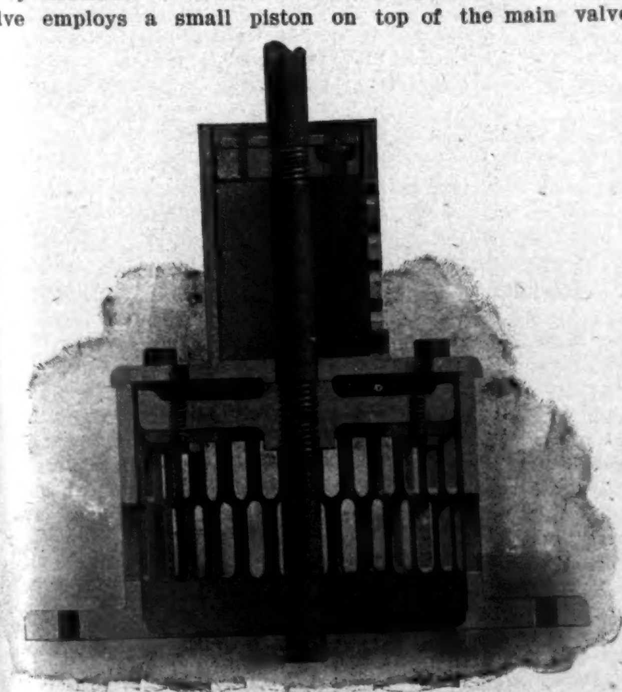
In the smaller engravings two forms of slow closing tank valves are illustrated. These were developed by Mr. T. W. Snow and F. S. Milne. With the increase in the

Improved Water Service, Delivering 5,000 Gallons Per Minute—Chicago & Alton Railroad.



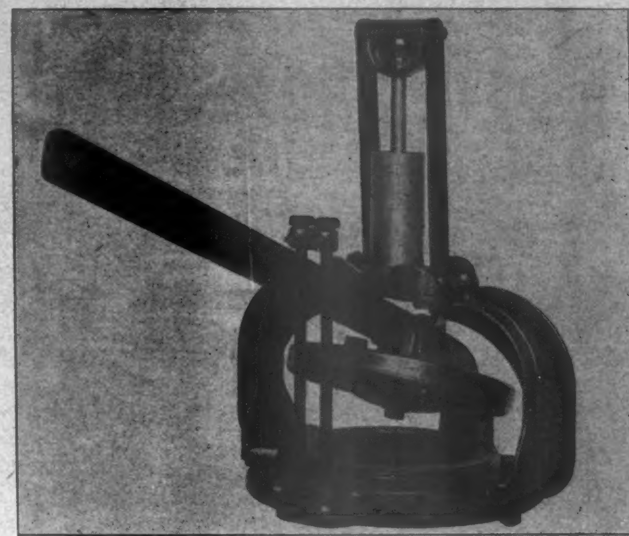
Water Tank, 90,000 Gallons Capacity. Chicago & Alton Railroad.

diameters of the valves some slow closing device was found necessary because of the destructive shocks of the heavy columns of water. The arrangement of the new valve employs a small piston on top of the main valve.



Slow-Closing Tank Outlet Valve.

This works in a cylinder in which four holes are drilled. The small cylinder fills with water and the holes offer sufficient resistance to the motion of the piston to retard its closing. In the small piston a check valve is provided which admits water to aid in the first upward movement of the piston. The valve



Slow-Closing Attachment for Tank Valves.

stem, which is of gas pipe, is perforated for the purpose of admitting air to the pipe below the valve in order to destroy the vacuum which would otherwise form after the closure of the valve. The dash pot shown on top of the ordinary tank valve in the other engraving is applied for the same purpose as the small piston shown in the sectional drawing of the new valve. This dash pot is 3½ ins. in diameter and the necessary resistance is secured through ⅛-in. holes. This dash pot is connected to the main valve lever by the two links also shown in the engraving.

PHYSICAL TREATMENT OF STEEL FOR RAILS.

Much has been said regarding the chemical and physical treatment of steel while being rolled into rails, but not until recently has the physical treatment been given due consideration by the modern rolling mills, in the matter of finishing its products at a reduced temperature. It is generally conceded that old rails after being rerolled wear better than when put into a track for the first time and that smaller sections of rails give better satisfaction than do the larger sections, both for the same reason that the metal has received more working, and that at a lower temperature. Capt. Robert W. Hunt, who is the recognized authority on rails in this country, read at the February, 1901, meeting of the American Institute of Mining Engineers, held in Richmond, Va., a paper on the "Finishing Temperatures for Steel Rails."

The paper sums up the efforts that have been made by the author and many others to bring about this necessary physical treatment. As the rush of the modern mill and its tremendous productions seemed to shut out the possibility of obtaining rails rolled at lower heats, the author advocated efforts to obtain from chemical composition that which could not be had from physical treatment, and so urged harder steel in proportion to the increase of section. Good results have come from such mixtures, but the author insists that the chemical composition is secondary to the physical treatment of the metal. There have been instances in the experience of many railway engineers where they have obtained excellent service from steel rails that were made in the earlier days, whose chemical analyses revealed the fact that they had neither good nor even consistent chemical character.

Now that the large section rail has been made universally necessary by the large increase in tonnage of railway traffic and weight of rolling stock, several of the rail companies have prepared plans for the alteration of their rail mills. The Carnegie Steel Company, having carried their plans into execution, are to-day rolling rails in their modified mills. The

Pennsylvania Railroad in their orders this year for rails specify that they must be finished at a low heat. This commercial recognition of the heat and work principle, Capt. Hunt believes, was brought about by the McKenna process of renewing old rails rather than by the quantity of talking and writing that has been given the subject. Thousands of tons of rails have been renewed by the McKenna process since the plant was established in 1895, and are giving very satisfactory service. Here was an actual demonstration that could not be denied.

As to just what this temperature should be for finishing rails and how to determine it, Mr. Thomas Morrison, General Superintendent of the Carnegie Steel Company's Edgar Thomson Works, who planned and executed the alterations in their mill, thinks that the distance between the hot saws which is found to yield a rail of the desired length will be a sufficiently accurate and practical controlling factor, as to the heat at which the rail is finished. In this Capt. Hunt agrees, but also considers that the Ducretet and Lejeune pyrometer would be of considerable assistance, as it gives quick and consistent results. By the use of this instrument the temperature of finishing 80-lb. rails in most mills under the old conditions averaged 1,795 deg. F. In the McKenna renewing mill at Joliet the finishing temperature is considerably reduced.

The rails are drawn from the reheating furnace at an average temperature of 1,750 degs. F. and when leaving the finishing rolls their average temperature was 1,480 degs. On the other hand, there is a danger of finishing at too low a temperature, more so with high than with low carbon steels. If the metal is too cold it will spring the rolls and the interior of the rail will receive no work, thus rendering the rails unsatisfactory. There is a patent owned jointly by Messrs. Morrison and Julian Kennedy covering the handling of rails previous to their final pass through the rolls, that has as its principle the arrangement of the rails on the intermediate table where the finishing pass is delayed. The flange, being the thinnest part of the rail, gives off its heat more quickly than any other part, and in order to keep the flange longer at a heat sufficiently hot to roll, while the temperature of the metal in the head is reduced, the flange of one rail is placed against the head of another, so that the flanges draw heat from the heads of the rails. The head of the outside rail to be first entered in the finishing pass is exposed, but the bottom of its flange is against the head of the next rail.

This new practice of rolling rails is considered by Capt. Hunt as a revolution in rail making and justifies a change in the larger sections of rails, which would have been just as necessary under other conditions. It therefore seems wise that the standard sections of 89, 90, 95 and 100 lbs. be modified so as to obtain the best results from this heat condition and that will also be well suited for rerolling into lighter sections; adhering, of course, to all the necessary features of the sections recommended by the committee of the American Society of Civil Engineers. As the society sections are now practically standard on the railroads of this country, they should be considered as a basis on which new sections are to be designed.

In a report recently presented to the American Railway Master Mechanics' Association the following statement was made regarding the heating and ventilating of round houses: "The most modern method of heating at present seems to be by hot air and forced blast. The air can be taken from the roundhouse and warmed over and over again, thus reducing the cost of heating the air. While this air is generally carried in overhead ducts, your committee considers it should be investigated and determined in each case whether an underground duct would not be suitable. It is also suggested that air be taken from the boiler room, thus serving the double purpose of cooling this room and using the heat imparted to warm the roundhouse."

FUEL OILS IN TEXAS AND CALIFORNIA.

Experience on the Southern Pacific Railway.

By Howard Stillman.

Engineer of Tests Southern Pacific Co.

Concerning the recent discoveries and remarkable output of oil in Texas much has been written, and because of its importance to the railroads which are able to avail themselves of this apparently enormous supply, the following valuable discussion, written for and published by the New York "Commercial" by Mr. Howard Stillman, M. A. S. M. E., Engineer of Tests of the Southern Pacific Company, is timely:

The Southern Pacific Railroad Co. has used fuel oil in locomotive service for several years, and is extending its use in proportion to the supply of this class of fuel.

As compared with coal the following data are shown in evaporative tests made with both fuels in locomotive service. Engines with which tests were made were of the same size and make and in similar service. The following figures show the results:

Service, passenger.	Fuel. Summerland and Los Angeles petroleum.	Fuel. Comax (bit.) coal.
Miles run	224	224
Mean number of cars in train	3.71	3.71
Weight of cars in train, tons	113.01	110.40
Actual running time, hours	7.55	7.63
Average steam pressure gauge, pounds	133	130
Temperature of feed water, deg. Fahrenheit	66	66
Gallons water evaporated	6,603	5,980
Pounds water evaporated	55,025	49,833
Gallons oil burned	755	......
Pounds fuel burned	6,040	8,043
Evap. water per pound fuel	9.11	6.19
Evap. from and at 212 deg. F	10.96	7.41
Pounds fuel to evaporate one pound water from and at 212 deg. Fahrenheit	.09124	.1349
Equivalent of fuels for equal evaporation, lbs.	1.00	1.48
Ditto, by measure	*168.9	‡1
Gallons water evaporated per gallon oil	8.75	......
Miles run per ton	74.14	55.72
Fuel burned per hour	*100	‡.537
Total ton mileage	25,314	24,730
Ton miles per pound fuel	4.191	3.074
Ton-miles per gallon oil	33.53	......

*Gallons. ‡Ton.

The above items are from the record of the fuel tests made with careful attention to weights and measures.

The proximate analyses of the Comax coal is as follows:

	Per cent.
Moisture	1.90
Volatile combustible	27.08
Fixed carbon	55.38
Ash	12.50
Sulphur	3.14
Total	100.00

The fuel oil used in the test was California product from the locality named, and ranging in gravity close to 16 degrees Beaume, its flash point being about 240 degrees Fahrenheit, fire point at 290 degrees Fahrenheit. In practice it is taken at a weight of eight pounds per gallon.

The California oil varies somewhat in the gravity, but the fuel oils as obtained from the Kern, Los Angeles, Summerland, McKittrick and other fields are represented in the results above shown. They are all dark brown or black heavy asphalt oils, being more or less oxydized petroleums, very thick and viscid at temperatures below 60 degrees, and can only be handled by use of steam heating coils in the tanks or around the pipes.

The grades of California petroleum are many and should not all be confounded with the fuel oil referred to. There is a wide range in quality for refining purposes, but by the term fuel oil we mean that it is supposed to be of use for little else than fuel, and this article has to deal more particularly with such.

As to the relative cost of either coal or oil fuel, the relative values are based on the figure from the above test for equal calorific effect from and at 212 degrees; that is to say, 168.9 gallons oil equal one ton of coal, to which ratio local prices may be applied. As to effect on flues, fire boxes, etc., there is rather more trouble from leaky flues, seams, etc., than with coal fuel. This is due not to the fuel, but to more rapid temperature changes in the firebox during service with its subsequent expansions and contractions. This applies particularly to the use of

oil fuel in locomotives, because its service is so irregular in shutting off steam, stopping, starting, etc.

We have used oil fuel in stationary service many years, and it was used as fuel for a long time on the ferry steamers on San Francisco Bay, with excellent results, but was abandoned on account of possibility of accidents on crowded boats and the public were timid. The writer had occasion as a part of his duty to make occasional inspection of the oil burning boilers of steamers Solano, Oakland and Piedmont. I am prepared to make the statement that I have never seen an instance of damage to firebox plates from use of oil fuel. Stationary boilers being regularly fired and not forced in evaporation as locomotive boilers are, do not suffer from the rapid expansions and contractions referred to.

The Texas fuel oil is in some respects quite different from the California oil. It has a gravity of about 22 degrees Beaume, flashes at 180 degrees, and fire point at 200 degrees Fahrenheit. Its commercial weight may be taken at 7.43 pounds per gallon. It is quite fluid at ordinary temperatures, and flows easily and readily in pipes, burners, etc. For refining purposes it is said by authorities to be of little value and good for little else than fuel. A quantity of this oil was hauled into Los Angeles and put to use on a freight engine in comparison with the California product. The chief variations found were as follows:

About 2 per cent. gain in evaporative effect was found in favor of the California oil, but the probabilities are that with continued use there will be little or no difference found. Theoretically, the Texas oil has the greater calorific value, owing to its containing a larger proportion of the paraffine or unoxidized oils.

In the comparative test a marked difference was found in the effect of the oil fire on the brick lining and arch of the firebox. The California oils contain more or less water of a salty or alkali nature, the effect of the alkali being to flux and melt out the fire brick to such an extent that removals are quite an item. The Texas oil is free from alkali, and it was observed that no destructive element was present to destroy the firebrick. The comparative fluidity of the Texas oil has already been referred to, and the difference in handling the oil was a matter of practical importance.

The smell of the burning oil or products of combustion of the Texas oil were noted by the locomotive engineer during his two weeks' experience with it. He said the odor wasnot as disagreeable as with the California oil. This was not as expected, owing to the quantity of sulphur in the Texas oil, but is explained by the fact that in complete combustion the sulphur is oxidized to sulphurous fumes not present in appreciable quantity.

The amount of sulphur in the Texas oil is considerable for petroleum, being determined at from 1½ to 2½ per cent. When the oil is distilled or heated below ignition point without access to air, a series of sulphuretted gases are given off, which are very disagreeable. Not so when the oil is burned in plenty of air. Oil refiners cannot make use of the petroleums containing much sulphur, and condemn the Texas oil on this account for fuel.

I wish to contradict the statement made in an Eastern oil refiner's paper that "The Texas oil would eat up the flues of an ocean steamer in once crossing the Atlantic on account of the sulphur." This statement had no foundation in fact, and I would contradict it from the following basis of observation:

The Southern Pacific Company for many years used on a portion of its lines a quality of coal known as Union, or Comax. This coal contained sulphur in considerable quantities, varying from 3 to 5 per cent. The sulphurous fumes were present in such quantity as to be objectionable to passengers and a general nuisance. Observations were made covering several years of the action of this coal on firebox plates, but I was unable to locate corrosion that could be traced to sulphur. The reason why no such corrosion can be expected is briefly explained as follows:

The fumes of dry sulphurous acid at high temperature are not corrosive to iron plates and cannot unite with them at temperature of the furnace. In presence of water and temperature less, say, than the boiling point of water, the corrosive acid is formed in time, but this condition is not found in an oil fire.

I would wish to go on record as denying any statement that the sulphur in Texas fuel oil will destroy the firebox of a marine boiler. For marine or stationary service we have never found an objection to oil fuel. When burned continuously in such service there is no complication and no better form of combustion can be desired or better fuel devised excepting gas, of course.

A cheap source of fuel oil such as the Texas field promises has a great future for steam production. They seem to have it on tap in enormous quantities. The California product may not be able to compete with it, as the California oil generally has to be pumped from wells varying from 800 to 1,200 ft. in depth. A 10 or 50 bbl. per day well in California is rated as a good one. In Texas there are four wells that yield under pressure from below 100 times as much oil per day.

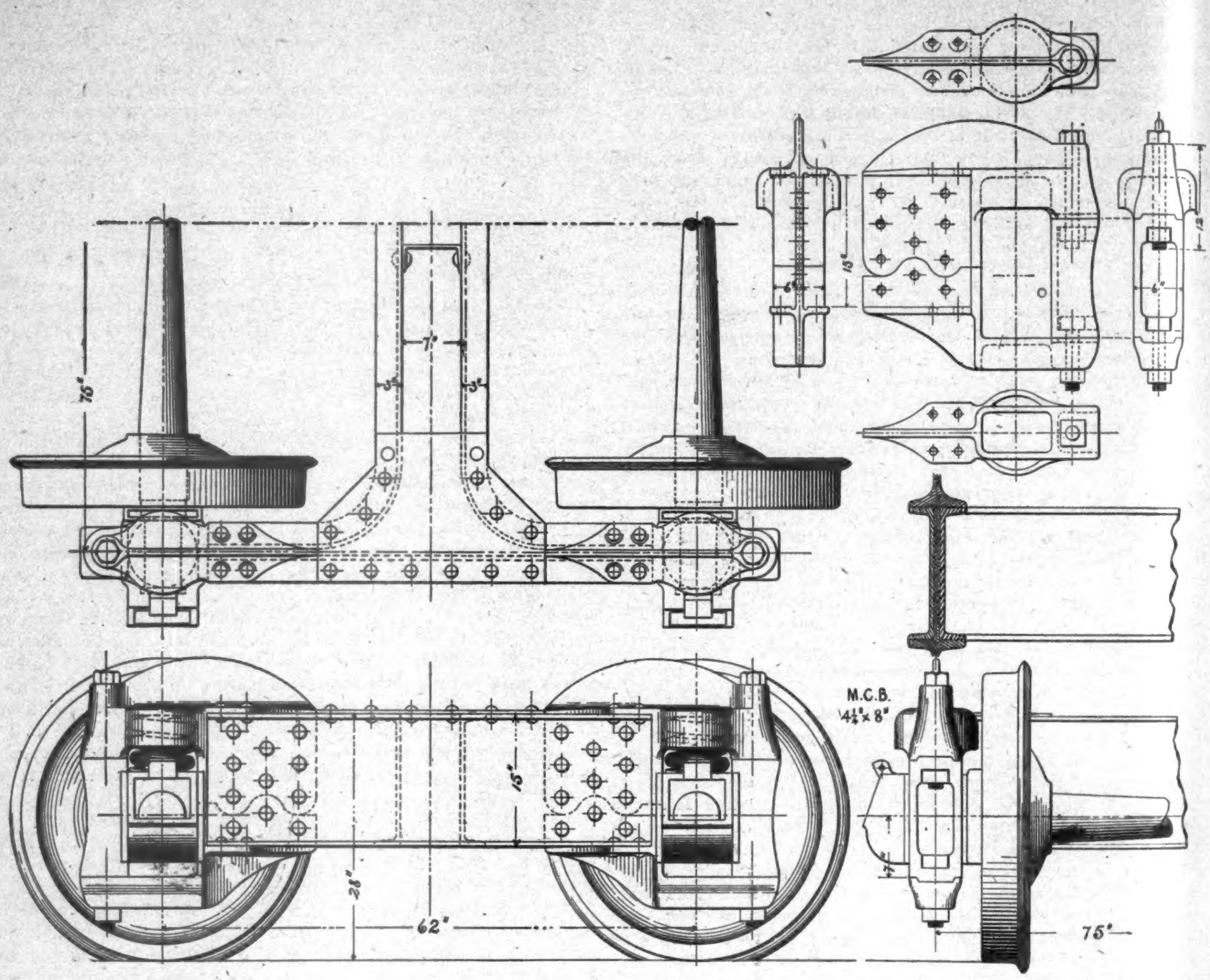
In connection with the use of Texas oil for locomotives the following quotation from an Austin correspondent of the St. Louis Globe-Democrat is interesting:

"The fact that the tests of the Beaumont oil as fuel for locomotives proved highly successful is of the greatest importance to several companies operating extensive railway systems in Texas. This is particularly true as applying to the Southern Pacific, the Atchison, Topeka & Santa Fe and the Gould lines. It is to be expected that the railroads, by buying in large quantities, as they now do coal, will be able to get fuel oil in the Beaumont field at a very low price, probably not exceeding 20 cents per barrel at Beaumont. The numerous tests which have been made show that this oil is a better steam producer for locomotives than much of the coal that is now being used. These tests have demonstrated that about 3½ barrels of oil are equal to one ton of coal for steam-producing purposes. It is asserted that 2½ barrels of the oil is equal to one ton of Indian Territory coal, which is used on most of the Texas roads. The reports made by the several railroads of Texas to the State Railroad Commission show that the total amount of coal used for locomotives on the Texas lines for the twelve months ending on June 30, 1900, was 1,716,471 tons. The price paid per ton for the coal ranged from $1.35, for which the Paris & Great Northern obtained it, to $5, which was the price paid by the Velasco terminal. The former road used 5,919 tons of coal during the year and the latter road only 525 tons.

"The total number of tons of coal used for locomotives by all the roads belonging to the Southern Pacific system in Texas during last year was 539,808, and the aggregate sum paid for this fuel was $1,764,970.04. Taking the liberal estimate that it requires 3½ barrels of the Beaumont fuel oil to equal one ton of coal, it is shown that the 539,808 tons of coal are equivalent to 1,889,328 barrels of fuel oil. Inasmuch as this oil is now being sold in large lots at 20 cents per barrel, it is reasonable to suppose that the Southern Pacific will be able to contract for it at that rate or even lower. At 20 cents per barrel, the 1,889,328 barrels would cost $377,865.60, as against $1,764,970.04, which was the sum paid for fuel for locomotives of the Texas lines belonging to the Southern Pacific system during the twelve months ending on June 30, 1900. This would mean a saving of $1,384,304.44 per annum in the company's fuel bill for its Texas lines alone. The cost of installing oil burners on locomotives is said to be about $300 for each locomotive."

LONG RUNS WITH LIQUID FUEL.

Concerning liquid fuel on the Great Eastern Railway of England, Mr. James Holden recently expressed a most favorable opinion of its use on long runs. In an article in "Engineering Times" he said: "On the long runs of fast trains, which are yearly increasing in number, one of the chief difficulties is the fire, which being continuously urged for such long intervals becomes choked with dirt and ashes. With oil-burning locomotives no such trouble exists, as the supply of fuel is regular, continuous and entirely free from residue. An engine of the Great Eastern Railway (761) had on a special occasion to haul an express train from London (St. Pancras) to Scarborough and back. The total distance covered was 532 miles, the engine being in steam some twenty-four hours. The fire was untouched during the whole time, and the engine steamed as freely during the last half-hour of the run as on its intitial fifty miles of the journey."



Steel Frame Pedestal Truck.

A NEW STEEL FRAME TRUCK.

The accompanying illustration shows a design for a pedestal truck which presents several novel features of construction. The main part of the frame, embracing the side pieces and transoms, consists of commercial rolled channel beams, the ends of the transoms being bent so that their extreme portions lie in planes parallel with the side pieces. Flat plates are riveted to the side pieces and transoms at their junctions to render the frame stiff and rigid and keep it square. Between the ends of the side pieces and transoms are inserted the necks of cast steel pedestals which are riveted in place. Each pedestal is cast in three pieces, the end piece being removably secured in position by two 1½-in. bolts. A pair of wheels can be rolled out by jacking up the frame a short distance to take the weight off the springs and removing the end pieces of the pedestals. The principal dimensions are shown in the several figures. This truck can be built in the ordinary car shop with the use of familiar tools and also can be easily repaired when necessary. The castings are simple and light and the pocket for the end of a spring adds the requisite strength where the weight is transmitted to the journal box. The designer, Mr. R. G. Wright, of Philadelphia, Pa., had in view the production of a truck which should be cheap in first cost, simple in construction, and adapted to be easily repaired in the ordinary car shop.

ICING STATIONS FOR REFRIGERATOR CARS.

A correspondent, who is an operating official, recently inquired why the principles followed in handling locomotive fuel from cars to tenders could not be applied to the icing of trains of refrigerator cars. He suggested the coal-chute idea for handling ice. Upon looking for information it was found that this was done on the Pittsburg, Fort Wayne & Chicago Ry. in the Sixteenth Street yards in Chicago several years ago The object is to ice the cars in trains, and to do it cheaply and quickly in order to permit of forwarding the trains without delay when they are iced in transit.

The refrigerator cars are placed on the track beside a trestle which carries the ice cars, and the ice is handled from the ice cars upon a long platform which is the proper height to skid the ice into the tanks in the refrigerators. The approach to the trestle is inclined with a grade of 2.2 feet per 100 feet, and is about 590 feet long. The icing platform is 156 feet long and level, the trestle is 300 feet long and about half is on the grade. The refrigerator track is 940 feet long, which is ample for the purpose. The trestle is supported on mud sills 12 by 12 inches in section and the bents are 12 feet apart, of 12 by 12 inch timbers. The stringers under the ice track are 8 by 18 inches.

This platform has been found very satisfactory. About 250 cars are iced per month, giving from 4,000 to 4,500 pounds of ice to each car. With this arrangement the ice may be carried along the platform in a small truck in which it is broken up and then dumped into the cars.

AMERICAN LOCOMOTIVES IN ENGLAND.

In view of the great difficulty in making a comparison between two locomotives or two classes of locomotives when all concerned use their utmost endeavors to get the real facts it is not at all strange that the American locomotives on the Midland Railway of England are reported to be wasteful. The reported extra working costs over the English engine in the same service for six months are:

Fuel	20-25%
Oil	50%
Repairs	60%

As to oil and repairs nothing can be said without knowing more than we know about the conditions, but with reference to fuel we believe that there is as much as 25 per cent. variation to be expected in the adjustment of the front end arrangements to suit English coal, plus a lack of personal interest in the success of the American engines which was to be expected, because of the bitter criticisms of the policy of buying the engines in this country. No one expected the American engines to come out ahead. It would not do at all to have them beat the English machines, even if they could do so under favorable circumstances—which we decidedly doubt. This is an opportunity, however, for a most interesting locomotive study, though it may not be made. It suggests a question which American designers would profit by satisfactorily answering, viz.: Why do English engines, in general, do such good work with such small heating surfaces?

There is no profit in blindly defending one's own practice in the face of an opportunity to improve it. This affair is merely an interesting example of American methods whereby an emergency was quickly and satisfactorily met. As a comparison it is equivalent to matching our rough and ready practice of years ago with the polished and highly finished methods of a conservative and steady development under the most highly concentrated attention the locomotive has ever had. It is utterly impossible to compare present representative American and English locomotives for reasons too well known to require explanation.

We confidently believe, however, that it would be profitable for an American road to import an English engine and make a study of its operation under conditions adapted to its capacity.

The following quotation from "Engineering" illustrates a broad-minded view, which is as intelligent as it is commendable:

"In regard to the detail of fuel economy, we should not be at all surprised to find that British locomotives have a superiority. It is a question, however, whether we in this country have not made fuel economy a feature to which too much has been sacrificed. It is a detail of expenditure, doubtless an important one, but it is possible to overestimate its value. The American railway manager takes the view that a few dollars extra spent on coal is a profitable outlay if it enables an engine to do more work, better time to be kept and other economies to be secured in regard to capital expenditure and wages.

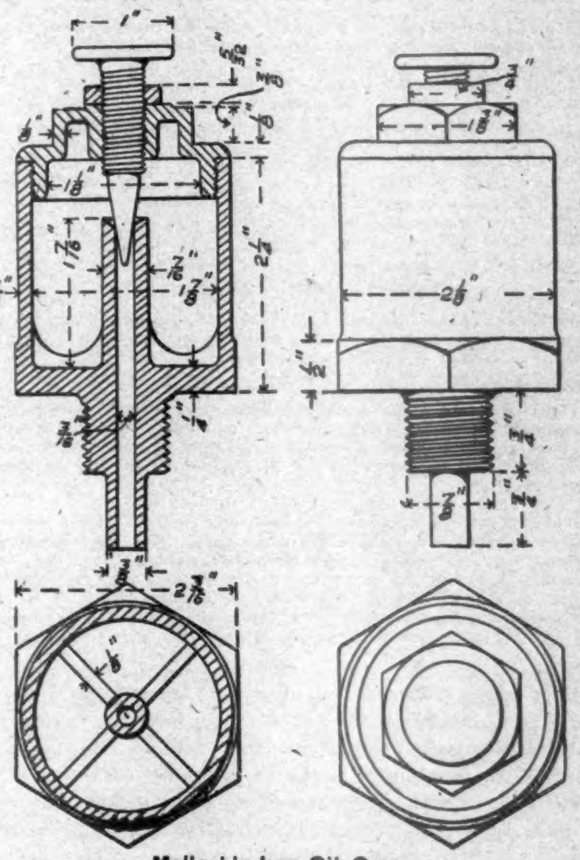
"These things, like other points raised, need working out quantitatively, so as to give a just balance on the total of expenditure and return. It may be that British engines would show a superiority. We cordially hope such might prove to be the case, but on the information we possess we are assured that American competition in nearly all branches of engineering industry is not a thing lightly to be dismissed, in the way that some optimistic persons in this country would have us dismiss it. This is more true of some other engineering products than of locomotives. Steel bridge builders, especially would do well to bear it in mind.

"It may be thought that we, like the railway officials (according to Sir Alfred Hickman), seem resolved to screen the Americans at all costs. We are careless as to such an accusation. Unlike Sir Alfred Hickman, we believe that American competition in the engineering industry is an extremely serious question, with which British engineers must deal in a most strenuous manner, and we are of opinion that it is the height of folly to put aside unpleasant facts by cavilling criticism on details."

MALLEABLE IRON OIL CUP.

Minneapolis, St. Paul & Sault Ste. Marie Railroad.

Theft and breakage of brass oil cups is leading many to the use of cheaper materials. The description of the malleable iron oil cup devised by Mr. McIntosh, of the Central Railroad of New Jersey, illustrated on page 323 of our October number of last year, attracted the attention of Mr. T. A. Foque, Mechanical Superintendent of the "Soo" Line, and led him to send us a drawing of a design which seems to have excellent features.



Malleable Iron Oil Cup.

This cup has a regulating needle similar to that of the New Jersey Central, but Mr. Foque has made it accessible from the outside of the oil cup without requiring the cap to be taken off in order to regulate the feed. It is held in the desired position by the lock nut on the top of the cup. This design has the additional advantage of placing the wrench at the bottom of the cup instead of the top, when screwing it into place. The desire to secure oil cups from loosening often results in too vigorous use of the wrench and the weakening of the cup if turned from the top, unless it is made very strong. Mr. Foque says that losses of oil cups by breakage and loosening from the rods are now almost unknown. His oil cup is not large, but it is found to be ample for all conditions of service.

A fast run made by the Chicago & Northwestern fast mail train June 30 from Clinton to Boone, Iowa, is worthy of record. According to the train sheet report the distance of 202 miles was made in 187 minutes actual running time, at an average speed of 64.8 miles per hour. The weight of the train exclusive of the engine was 179 tons.

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

Matters in car design are moving very rapidly just now, and when it is remembered that there have been but about four years' experience with steel cars the progress is remarkable. In addition to the many designs of cars built entirely of steel a large number of wooden cars with steel underframes have been brought out. It is in this direction that the chief development of the immediate future may be expected, and particularly now that it is practically assured that the American Railway Association is to recommend a standard car at its next convention. Much has been heard of late concerning the weaknesses and inadequacy of draft gears, but little has been heard concerning the increased expense of maintaining cars having wooden underframes. Recently a representative of this journal, in looking up the subject of steel cars, discovered that one large road has reached the conclusion that in these days of heavy trains and powerful locomotives it does not pay to build cars with wooden underframes. In investigating a large increase in the cost of repairs of wooden cars, particularly for end sills and longitudinal sills, it was found that the trouble was by no means confined to old and weak cars, but that it applied equally to well-constructed and relatively new cars of 30 tons capacity. On the other hand, steel cars of large capacity had given almost no trouble in these parts. This led to the important decision to at once establish the rule that in future construction steel underframes will be used for all standard freight cars, whatever the type. On the road referred to it is the opinion that it will not pay to continue to use wooden sills, and that present methods of operation will soon drive all roads to this conviction.

While the mechanical departments of American railroads are being crowded in the matter of capacity of locomotives, and with the present tendency will find it difficult to meet the requirements for power, it is clear that in the capacities of cars they are far ahead of the present abilities of the operating departments in the matter of loading. The increase in capacity of the freight car has not been accompanied by a corresponding increase in the loads carried, and considerable improvement will be necessary before the increased cost of 40-ton above that of 30-ton cars will be earned. A competent authority places the actual loading of cars at not above 55 per cent. of the nominal capacity, considering the railroads of the country, as a whole. It is only in grain, coal, ore or similar traffic that full loads are always insured, but by careful watching of the loading at local points the average of miscellaneous freight will gradually be raised. There is now a great waste of equipment, and the benefits to be derived from increasing car loadings will be apparent at once. They will appear in decreased car mileage, decreased train mileage, switching cost and in increased earning capacity of the entire road because of the more profitable use of facilities. The present situation is not in the least an argument for smaller cars. It is the strongest argument for larger ones. It shows, however, the deficiencies in present methods of loading.

A new and probably entirely unexpected development from the wholesale application of air brakes and improvements in modern car construction has become noticeable. With the increased number of freight cars equipped with air brakes, it is no longer necessary for the brakemen to spend a large part of their time on the top of the cars, because the brakes are handled by the engineer and the brakemen spend a large proportion of their time in the caboose. That there is a strong tendency for them to do this is unquestioned, and with the increasing lengths of trains, due to the increase in the capacity of locomotives, this has brought about a situation which may become dangerous. In fact, it has already done so. Recently a large steel shaft for a stationary engine broke loose from its fastenings on a flat car in transit over a well-known railroad and it fell across the rails of the adjoining track, just before the arrival of a passenger train going in the opposite direction. Fortunately it fell at a spot where it closed the rail circuit of the automatic signal system and put to "danger" the automatic signal controlling that track. The passenger train was stopped in time to avoid a serious accident. In this case the freight train was well supplied with air brakes and the trainmen, not being required to go over the train, were not aware of the loss of the shaft until their attention was called to it by persons not connected with the train. This incident indicates the advisability of inaugurating a systematic method of inspecting the train in order to take the place of that which was formerly done through the necessity for the man to go over the cars frequently. In passenger service a somewhat similar difficulty exists. Because of the tightness of the vestibules and the gradual increase of the lengths of runs between stops for fast trains, it is beginning to be appreciated that hot boxes are not as easily detected as formerly. Several roads have recently experienced the entire burning off of journals through failures of the trainmen to detect hot boxes in time. The vestibules render it difficult to detect them by the odor and it is evident that something new in the way of inspection is needed in passenger service also.

In establishing locomotive ratings there seems to be a tendency toward overdoing the tonnage by assigning more than a locomotive can be sure to haul satisfactorily to the operating department. It is far better to allow too much rather than too little lee-way for the condition of the weather and rail. It is also advisable to allow some elasticity as to speed so that when necessary a little spurt may be made to assist the movement of other trains. Considerable criticism of the mechanical

departments may be avoided by care in considering these variables in the preliminary ratings. There is no thing that will earn the epithet "theoretical" more quickly than to offer a rating which burdens the operation of trains.

PERSONALS.

H. L. Preston, for the past 17 years Master Car Builder of the Chicago, St. Paul, Minneapolis & Omaha, died at his home in Hudson, Wis., June 28.

Mr. Joseph O. Osgood has been appointed Chief Engineer of the Central Railroad of New Jersey to succeed Mr. J. H. Thompson, assigned to other duties.

Mr. J. H. McConnell, recently Superintendent of Motive Power and Machinery of the Union Pacific, has been appointed Manager of the Pittsburgh Locomotive Works.

Mr. J. H. Stubbs, General Foreman of the Union Pacific shops at Armstrong, Kan., has been appointed Master Mechanic, with headquarters at North Platte, Neb., and will have jurisdiction over the main line of that road from Grand Island to Cheyenne.

Mr. Wm. A. Nettleton, Superintendent of Motive Power and Machinery of the Kansas City, Fort Scott & Memphis and the Kansas City, Memphis & Birmingham, has resigned and Mr. F. A. Arthur is appointed Acting Superintendent of Motive Power and Machinery.

Mr. Frank W. Morse, Superintendent of Motive Power of the Grand Trunk, has been appointed to the position of Third Vice-President and Assistant General Manager, and Mr. W. D. Robb, Master Mechanic of the Middle and Southern Divisions, is in turn appointed Acting Superintendent of Motive Power of that system.

Mr. W. S. Haines has been promoted to succeed the late F. W. Diebert as Assistant Mechanical Superintendent of the Baltimore & Ohio at Newark, Ohio. Mr. Haines is succeeded at Mount Clare by Mr. H. M. Brennan, who was formerly chief boiler inspector.

Mr. A. E. Mitchell, who has been Superintendent of Motive Power of the Erie Railway since 1892, has been appointed Mechanical Superintendent of that road and his former position has been abolished. Mr. Mitchell has had a very wide and successful experience and is one of the best-known motive power officers in this country.

Mr. Joseph Ramsey, Jr., Vice-President and General Manager of the Wabash, has been elected President of that road to succeed Mr. O. D. Ashley, made chairman of the board of directors. Mr. Ramsey has been Vice-President and General Manager of the Wabash for the past five years and was formerly General Manager of the Cleveland, Cincinnati, Chicago & St. Louis.

Mr. A. H. Fetters, has resigned his position with the Baldwin Locomotive Works to go to the Union Pacific Railroad as Chief Draftsman. He was formerly with the Erie Railroad in a similar capacity and then Assistant to Mr. T. H. Curtis, Mechanical Engineer of that road. Mr. Fetters is a graduate of Lehigh University and received his early training at the Baldwin Works where he was a draftsman for seven years.

Jacob S. Rogers who, for many years was the owner and head of the Rogers Locomotive Works, died in New York July 2, at the age of 77 years. In 1856 he took charge of the locomotive works which had been founded by his father. In 1891 Mr. Rogers placed the management in the hands of Mr. R. S. Hughes, who continued in charge until his death two years ago. At that time Mr. Rogers announced his intention to sell or close the works in spite of the fact that they were busy and on a satisfactory paying basis. They have been sold, as recorded in these columns, and are now running.

Mr. Walter D. Crosman, who was for many years engaged in editorial work on the Railway Review, Railway Age and Railway Master Mechanic in Chicago, has resigned his editorial charge of the last-mentioned publication to become the Western Representative of the Gold Car Heating Company, with headquarters in the Rookery Building in Chicago. Mr. Crosman's long and thorough familiarity with technical railroad subjects and his exceptionally wide acquaintance will be specially valuable in his new undertaking, but we regret his loss to the profession with which he has been identified so long and so successfully. Having, however, made the decision to lay aside the arduous work of the editor, he is to be congratulated upon his new position and the Gold Company upon securing his services.

Mr. J. F. Deems, Assistant Superintendent of Motive Power of the Chicago, Burlington & Quincy, has been appointed to succeed Mr. F. A. Delano as Superintendent of Motive Power with headquarters in Chicago. Mr. Deems has had a long and successful experience on this road, his rapid progress beginning in his promotion from the position of Master Mechanic at Ottumwa, Iowa, to a similar position at Creston, about six years ago. He has long been considered as a leading motive power officer in the Middle West and is sure to be a credit to the succession of such men as Mr. Rhodes and Mr. Delano. His thorough and painstaking methods, his conscientious and business-like conduct of his work, together with fair and open handed treatment of his subordinates, we should say, are the reasons for his success. We cannot help commenting upon the desirability, of which this case is an example, of the policy of developing the staff of a department so that the advance of its chief finds a well qualified successor already in the employ of the road.

Mr. P. S. Blodgett, who has recently become General Superintendent of the New York Central, and formerly held the same position with the Lake Shore, was recently presented with a testimonial of esteem from his former associates in the form of the finest watch which the Webb C. Ball Company of Cleveland makes. The presentation was informal and the feeling leading up to it was unquestionably appreciated.

We are continually receiving requests for references of good men for positions as foremen, draftsmen, and particularly for leading draftsmen who can take complete charge of locomotive work, keeping several other draftsmen busy. We shall be glad to receive additional applications from men qualified to fill these positions and especially request the large number who have secured positions through our aid to notify us of the fact and give us their new addresses. There is no charge whatever for this service. Our object is to encourage young men and to assist in placing them advantageously. Our compensation is in the satisfaction of bringing together the men and the opportunities. The list is large and has been very valuable to many young men and to the railroads. It can be made more so if all those who desire and are qualified for better positions will meet us halfway.

A delay of but 22 hours from service for the repair of a locomotive frame by welding is a record performance described recently before the Pacific Coast Railway Club. It was done at the West Oakland shops of the Southern Pacific by aid of an oil burner. Little boxes of fire brick were built around one of the frames that was broken in two places and with an oil flame from an atomizer burner the frame was heated sufficiently for welding, the work being done without removing the frame from the engine. This engine broke down at night, 20 miles from the shop, and was back at the same place ready for work in 22 hours. The welds were under the rocker box and the work was done before the steam had died off in the boiler.

WESTINGHOUSE ELECTRIC BRAKE AND HEATER.

This apparatus combines the brake with the heater. The power of the brake is derived from magnetic track shoes and the heater derives its heat from the electric energy of the motors used as generators. The two parts of the apparatus may be used independently or together. It is a remarkably ingenious and almost ideal combination. The brake operates independently of the trolley current, a great safeguard.

The Brake.

The brake proper comprises a double shoe combined with a powerful electro-magnet, which, when energized by the car motors acting as generators, is strongly attracted to the rail by magnetic force, combined with brake heads and shoes of the ordinary type, acting directly on the wheels and constituting a wheel brake of maximum power and efficiency, and various castings and forgings for simultaneously transmitting the downward pull and resultant drag of the magnetic track brake into lateral pressure upon the wheels. The combination of these three elements in duplicate, together with the necessary tie-rods and attachments, constitutes an equipment designed for application to a four-wheel, or single-truck car; a double-truck equipment is required for an eight-wheel car. In addition to the truck equipment, a complete brake includes brake controller attachments for use when the motor controllers are not provided with braking points, and a diverter, or improved form of rheostat, for dissipating any excess of heat when the heaters are not in service.

Figs. 1 and 2 illustrate the arrangement and construction of the apparatus; also the method of attaching the brake rigging to the truck, and of suspending the track shoes and magnet frames. When the brake is not in operation the suspension springs carry the track magnets and shoes, entirely clear of the rails, and by means of their flexibility, permit the shoes to ride over any obstruction not sufficient to cause the car to be stopped. When the brake is applied (through the saturation of the magnets with current supplied by the car motors acting as generators) three distinct effects are produced: 1. A noticeable increase in the pressure of the wheels on the track, because of the downward pull of the magnets; 2. A pronounced retardation by reason of the friction generated between the track shoes and rails; 3. A maximum braking effect on the wheels, obtained through the transmission of the resultant drag of the track shoes to the brake shoes.

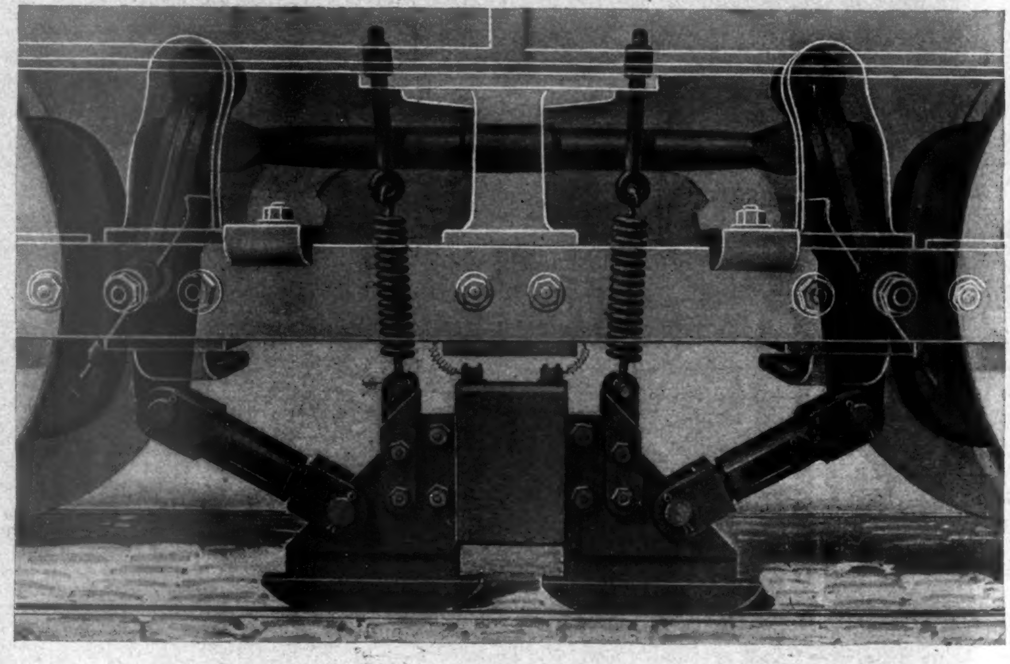


Fig. 1.

The net result of these three effects is a much higher braking power than can be obtained by the use of any other brake without skidding the wheels; moreover, the feature of a powerful track brake, which, instead of decreasing the weight upon the rails at the wheels, actually increases it, is as unique as it is valuable, and it is in this feature that this brake differs from all other track brakes. Other forms have proved distinctly inferior because of their tendency to decrease the hold of the wheels upon the rails. It is highly important not to lessen but rather to increase the pressure of the wheels upon the rails in the manner obtained by the magnetic brake. While the thrust against the wheel-brake shoes, caused by the drag of the track shoe is similar to the thrust obtained in the well-known air-brake, the magnetic brake has a decided advantage in that the brake-shoe pressure is automatically regulated by the condition of the rail surface. This is a fortunate feature, which gives the highest braking power at all times without danger of wheel-sliding.

There is still another automatic adjustment of braking effect, scarcely less interesting, if somewhat less important. It is well known that, when the motion of the car is being rapidly retarded, the forward wheels carry a somewhat greater proportion of the weight resting upon the truck: from this it follows that by placing the fixed lower fulcrum of the forward brake-shoe lever slightly above the pin connecting it with the telescope rod, as shown in Fig. 1, a brake-shoe pressure is applied to the forward wheels proportionately greater than that acting upon the rear wheels; when the car is reversed, the governing conditions are also reversed and entirely satisfactory results attained—the levers and connections being so designed that, when properly adjusted, the highest possible braking power is secured, without reference to the direction in which the car moves.

As previously explained, the track magnets are energized by current obtained from the car motors acting as generators, which not only obviates any expense in that connection, but also effectually prevents the possibility of accident through sudden failure of line current. The current necessary for the required magnetization is uniformly kept within safe limits by a proper adjustment of resistance always in circuit with the brakes, thus avoiding any injurious effect on the motors.

An additional advantage gained by the use of the magnetic brake is found by employing an improved form of rheostat, or diverter (which has a constant resistance regardless of the heating produced by a continuous flow of current) in the automatic control of speed down long and steep grades. This result is owing to the fact that a certain resistance in the rheostat insures a fixed current flow at a given speed; and this resistance can be readily adjusted so as to permit just enough current to pass through the track-shoe magnets to hold the car at the required speed, against the action of gravity, on any grade: any increase in speed increases the current and causes the brakes to act with greater force, while a decrease in speed instantly decreases the current and the brake action at the same time, so that the speed of a car may be automatically regulated within narrow limits regardless of changes in the gradient. This brake can be readily applied to trail cars by properly

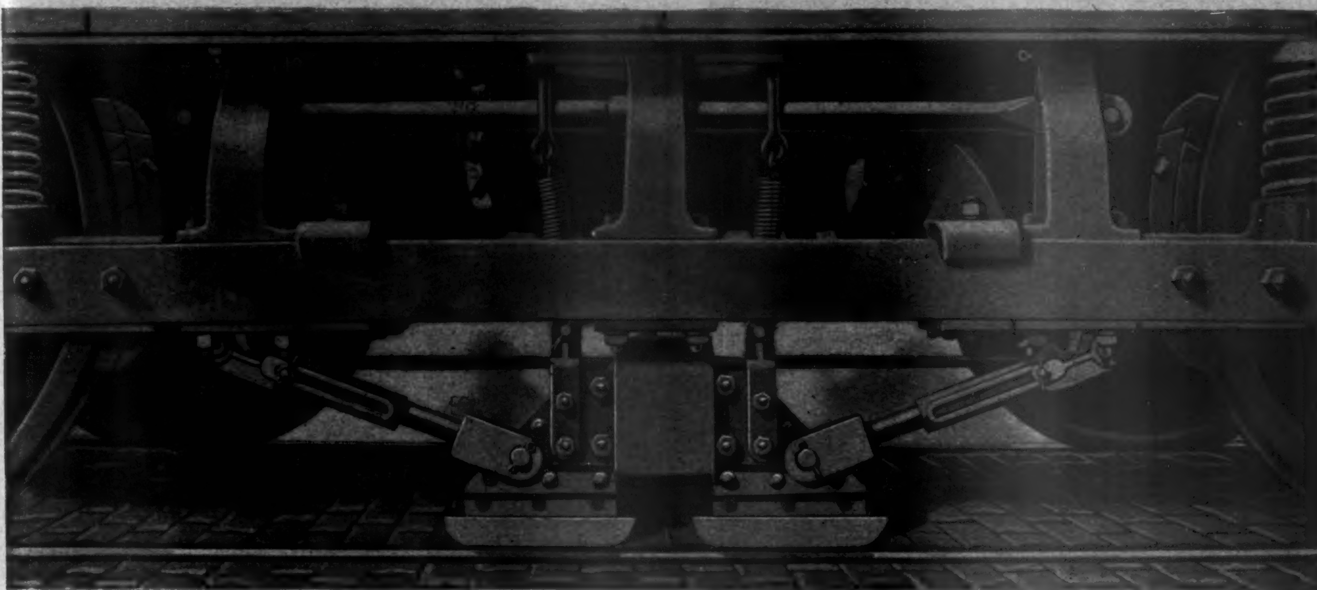


Fig. 2.

attaching the track magnets and accessories to them and connecting the magnetic coils to the wiring system of the motor car.

The Heater.

The heaters are connected with the general system of wiring by means of a suitably arranged switch, so constructed that the braking and starting currents, both of which are used for heating the car in cold weather, may be divided as desired and the whole or any portion thereof sent through the heaters, the remainder going through the proper portion of the diverter beneath the car. Whatever portion of the total actual current is flowing through the heaters flows through every section alike, which results in heating the car uniformly, no matter how small the amount of heat required. The ordinary electric car heaters, in which the heat is generated by line current, have so small a storage capacity that they are cooled to atmospheric temperature very quickly when, for any reason, the current is interrupted. An important advantage of this heater is its great capacity to store and retain heat within its mass. In the event of blockades or of the failure of line current from any cause this heat storage capacity is so great that the car is kept comfortable for an hour or more, even in severe weather.

EDISON'S NEW STORAGE BATTERY.

We believe we violate no confidence in stating that Dixon's Pure Flake Graphite forms one of the materials in Edison's new storage battery, which is attracting such marked attention throughout the world. The manner in which the graphite is used is explained by Mr. Edison as follows: "The construction of one cell is as follows: In a steel sheet a number of holes are punched—twenty-four, in fact, and in each one is placed a steel box, thin and perforated with minute holes. The active material is made in the form of briquettes, and is contained in these little steel boxes. The briquettes are condensed under a pressure of one hundred tons, which insures their being absolutely rigid. The positive briquettes are composed of a finely divided compound of iron obtained by a special chemical process, mixed with an equal portion of graphite. The graphite does not enter into any of the chemical processes, it simply assists the chemical conductivity. The negative briquette is obtained by similarly mixing finely divided nickel, also obtained by a secret process, with an equal bulk of graphite. This is solidified in the little steel boxes as in the case of the iron. These two plates, one containing twenty-four of the iron and graphite boxes, and the other twenty-four of the nickel and graphite boxes, constitute one cell of the battery. Of course, there can be as many of these cells as the experimenter desires to use. The two plates are placed in a vessel containing the potash solution, and the primary cell is complete."—"Graphite."

MECHANICAL STOKERS VS. HAND FIRING.

The efficiency of firing boilers by mechanical stokers has never approached the best performance of hand firing and there is no reason to expect them to exceed it, even if they should equal it. There are advantages, however, in favor of mechanical stokers in many plants, as they often save a large proportion of the labor. A cheaper grade of coal may be used. And the cost of repairs on the boilers is often diminished by reason of the more even temperatures. But there are many advantages offered in favor of the mechanical stoker which are based on the results obtained from comparative tests of stokers against hand firing, which are not fair comparisons, as the furnaces chosen for this purpose are usually old and inefficient ones, while the stoker furnaces are new and well laid out. We would naturally expect the stokers to prove more favorable in such cases. And again, tests unfavorable to stokers might occur if an old stoker plant was tested and then replaced by a first-class furnace arranged for hand firing.

There are few cases where an increase of efficiency in the use of coal will alone warrant the expense of stokers. Those responsible for a plant contemplating the use of stokers should then consider carefully the saving on labor, the prevention in smoke and ascertain if their use will permit of a cheaper grade of coal being burned than could be burned by hand firing. Many plants have been installed on the strength of the use of cheaper coals, when slight changes in the grates or furnaces would have enabled the cheaper coal to be burned by hand and at a much smaller expense.

In small plants containing one or two boilers there is no saving in labor and there is hardly a case in such plants where stokers will even begin to pay interest on their cost. On the other hand, many large plants, especially those running twenty-four hours a day, will show the use of one of the first-class automatic stokers to give a very satisfactory net return on the cost of its installation, by reason of the saving in labor alone.

Messrs. R. S. Hale and J. S. Codman, in an article on coal saving by means of mechanical stokers ("Mechanical World"), gives the best authentic performance of hand firing as 86.8 per cent. without the use of an economizer and an efficiency of 90 per cent. with the use of an economizer, which is, as yet too high a figure for the mechanical stoker to reach.

At a cost of between $15,000 and $20,000 the Boston & Maine management has again gratuitously supplied its employees with new uniforms.

RULES FOR INSPECTION OF SAFETY APPLIANCES,

WITH CLASSIFICATION OF DEFECTS TO BE REPORTED.

Adopted April 1, 1901, by the Interstate Commerce Commission.

Rule 1.

A.

Previous to examining equipment, inspectors shall make themselves known to the foreman or other official of the mechanical department, or, in the absence of that officer, to the agent or other employee next in authority. In all cases have name and title of such officer or employee included in report of defective cars. Whenever practicable, the official found in charge should be invited to acompany or send a representative with the inspector, and the person so accompanying the inspector should have his attention drawn to all defects likely to endanger life or limb.

Rule 2.

B.

Report location of all curves in yards and sidings where M. C. B. coupler will not couple or remain coupled, the practice generally followed where such curves exist, and whether any special device is employed.

Rule 3.

C.

Section 1. Secure information when practicable in reference to practice of handling brakes on descending grades. Ascertain whether hand brakes are used, and to what extent.

Sec. 2. Ascertain what inspection is given to air-brake cars leaving terminals, and whether engineers are informed of exact number of air-brake cars with effective brakes.

Sec. 3. Observe closely whether air-brake defect cards are attached or not. These cards are of two kinds: One designates that the car can not be placed between air-brake cars at all, on account of certain defects; the other signifies that the car may be used with air-brake cars as a means of continuing the connection, but that the brake on that particular car is inoperative. These cards indicate defects which should be repaired promptly; report if this is done.

Sec. 4. Pay special attention to the making-up of trains with reference to the placing of air-brake cars in forward end of train.

Sec. 5. Inspect heavily loaded cars sagging in the middle for leaky air pipes.

Rule 4.

D.

Section 1. Special attention should be given to grab irons on roofs of cars, and when reporting loose grab irons, state whether secured with lag screws or bolts and to a substantial part of car frame.

Sec. 2. As loose handholds and grab irons may originate in car shops, observe closely new cars and those a few months out of shop. Report all defects found in running boards and ladders, whether constructed of iron or wood.

Sec. 3. Report as to the result of the use of pivotal couplers on locomotives assigned to switching.

Sec. 4. Note to what extent men have to go between cars to couple them during the making-up of trains. Also to what extent men step in to open or close knuckles by hand. This should be ascertained by careful observation.

Sec. 5. State whether locomotives are equipped with M. C. B. type of coupler, noting if on end of tender only or on tender and front end.

Sec. 6. State fully all particulars of any other than the M. C. B. type of coupler found on coaches or cars of all kinds.

Sec. 7. Note on report of defective cars whether your inspection was made prior to inspection by railway company's inspector, and, if possible, show disposition of cars found defective.

Defects of Couplers and Parts.

1. Broken coupler body. 2. Broken knuckle. 3. Broken knuckle pin. 4. Broken locking pin or block. 5. Bent locking pin or block. 6. Wrong locking pin or block. 7. Wrong knuckle pin. 8. Worn locking pin or block. 9. Worn couplers or knuckles, as per M. C. B. limit gauge. 10. Short guard arm. 11. All missing parts of coupler complete, except cotter pins in knuckle pins. 12. Inoperative locking pin or block

Nos. 5, 6 and 7 are defective only when interfering with safe operation. Nos. 8 and 9 are defective only when worn sufficiently to destroy contour line by allowing lost motion to approach the danger point as shown by M. C. B. limit gauge.

Defects to Uncoupling Mechanism.

21. Broken uncoupling lever. 22. Broken chain. 23. Broken end lock or end casting. 24. Broken inner casting or keeper. 25. Bent uncoupling lever. 26. Chain too short. 27. Chain too long. 28. Loose end lock or end casting. 29. Loose inner casting or keeper. 30. Wrong end lock or end casting. 31. Wrong inner casting or keeper. 32. Uncoupling lever improperly applied or of wrong dimensions. 33. Missing uncoupling levers, and locks or end castings, inner castings or keepers, chain, clevis or clevis pins. 34. Chains kinked, making them too short.

No. 25 is defective when interfering with its proper operation or making it difficult to operate. Nos. 28 and 29 are defective when the proper operation of the uncoupling mechanism is interfered with. Nos. 30 and 31 are defective when interfering with proper operation of uncoupling lever to the coupler for which it was designed. No. 32. Under this head report all uncoupling levers which are too long, too short, too close to cars or other parts; give details of each. Judgment should be used in connection with the defects under No. 32.

Defects of Visible Parts of Air Brakes.

41. Defective triple-valve casting. 42. Defective reservoir casting. 43. Defective cylinder casting. 44. Defective cut-out cock. 45. Defective release cock and broken release rods. 46. Defective angle cock. 47. Defective train pipe (broken or loose). 48. Defective cross-over pipe. 49. Defective hose. 50. Defective hose gasket. 51. Defective brake rigging, beams or brake shoes. 52. Defective retaining valve. 53. Defective retaining-valve pipe. 54. All missing parts. 55. Air brakes cut out; when possible give reason why. 56. Whether cylinder or triple valve has been cleaned in six months preceding. 57. Whether locomotives moving interstate traffic are equipped with driver brakes and appliances for operating the train brakes.

Note.

Defects Nos. 41, 42, 43 and 48 are such as ordinarily exist only after cars have been wrecked, but are mentioned here to define the defects of visible parts.

Defects to Handholds.

81. Handholds missing. 82. Handholds improperly applied. 83. Handholds bent. 84. Handholds broken. 85. Handholds loose.

Note.

Application of handholds and grab irons should be governed by recommended practice of the M. C. B. Association. A standard location for these parts is essential for safe operation at all times and especially at night.

Defects in Height of Drawbars.

91. Empty cars too high. 92. Empty cars too low. 93. Loaded cars too low. 94. Loaded cars too high. 95. Loose carrier iron or stirrup.

Note.

On standard-gauge roads the maximum height is 34½ ins., measured from level of tops of rails to the center of the drawbar (coupler body) or corresponding line in coupler head. Greatest variation allowed from such standard height between drawbars of empty and loaded cars is 3 inches.

On narrow-gauge roads the maximum height is 26 ins.; extreme variation allowed between drawbars of empty and loaded cars is 3 ins.

Inspectors must exercise judgment in determining defects of this class. See that car is standing on an approximately level track before measurements are taken.

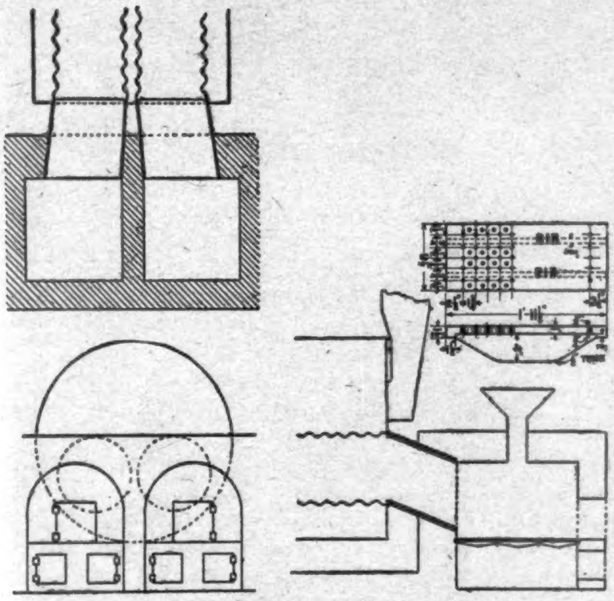
Minimum height for loaded or empty cars, standard or narrow gauge, is 31½ ins. An empty car having a drawbar 31½ ins. high is defective because when loaded it must fall below the minimum of 31½ ins.

It is certainly an impressive fact that if all the standards of length in existence should by any means be lost or destroyed skilled mechanicians can now reproduce these standards within the limit of error of one millionth of an inch. Such refinement is interesting to all and while its practical value is limited to the field of physical research one can but admire the skill of those who can measure and work to these limits. Professor Gale describes his methods and apparatus for doing this in recent numbers of the "American Machinist."

FUEL VALUE OF SAWDUST.

The fuel value of sawdust and pine edgings compared with Youghiogheny coal is given by Mr. F. W. Cappelen, City Engineer of Minneapolis, in a recent issue of "Ryerson's Technical Library." At the north side pumping station of that city is a battery of six corrugated boilers with Morison suspension furnaces.

The sawdust is fed automatically by a chain carrier delivering it through a hopper into an outer furnace provided with closely set grates, the bars of which are pierced with holes. The flames and gases pass from this outer furnace through an inclined steel plate extension to the boilers, thence through the Morison corrugated furnaces in the usual way. The sawdust may be quite wet and yet burn freely. A diagram of the arrangement of the furnace is presented in the accompanying engraving.



Arrangement of Firebox for Burning Sawdust.

Mr. Cappelen gives the following figures as to the fuel value of sawdust and pine edgings, as compared with the best lump coal in the plant in question:

It requires 3.98 cords of fairly good sawdust to pump 1,000,000 gallons of water against a lead of 193 ft.

It requires 1.88 cords of dry 4-ft. edgings to do the same work.

It requires 2,146 lbs. of Youghiogheny lump coal to do the same work.

This would indicate that a cord (128 cu. ft.) of sawdust had the fuel equivalent of 538 lbs. of coal, in actual practice, though the fact that the coal and the edgings are fed directly into the boiler furnace, while the sawdust is burned in an outer oven, involving a loss of heat before reaching the furnace, would show a theoretical value considerably greater.

The proposed School of Technology which is to be established in the city of Pittsburg by Mr. Andrew Carnegie will probably consist of three grades of schools to be called the Carnegie Technical College, the Carnegie Technical High School and the Carnegie Artisan Day and Evening Classes. The Technical College will teach all branches of engineering to high school graduates. The Technical High School will provide for the graduates of the grammar school instruction in foundry practice, pattern making, brass foundry, metal working, steam engine and steam boiler operation, gas manufacturing and electricity. The Day and Evening Classes will offer opportunities in technical training to those who cannot take advantage of the more complete courses. This is an outline of the report of the advisory committee appointed by the board of trustees of the Carnegie Institute of Pittsburg to prepare a plan.

BRAKE SHOES BY THE AMERICAN BRAKE SHOE COMPANY.

A little pamphlet recently issued by this company contains the following concise resume of the objects sought by each type of shoe manufactured by them:

Driving Brake Shoes.

Skeleton Steel—Maximum strength, minimum weight, maximum tire dressing.

Skeleton Steel Inserts—Strong dressing effect, strong frictional effect, durable.

Diamond "S" Skeleton—Maximum frictional effect, moderate dressing effect.

Improved Combination—Maximum durability, with strong dressing effect.

Reinforced Steel Insert (Herron) Driving Shoes—Maximum strength, strong dressing effect, durable.

"U" Shoe, Ross or Skeleton—Maximum durability, maximum frictional effect.

Coach and Car Shoes.

Flange Diamond "S"—Maximum friction, best results on tires.

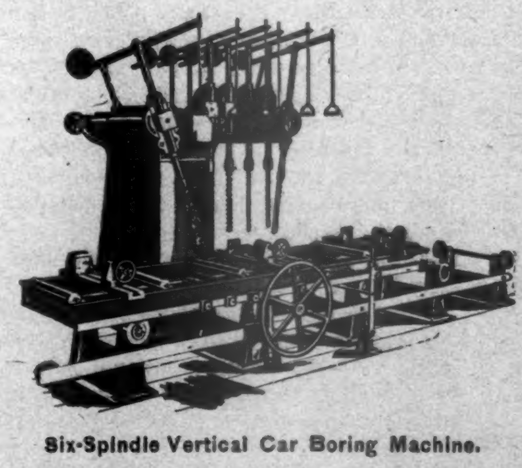
Unflanged Diamond "S"—Strong retarding effect, effective service, good durability.

The "U" Brake Shoe—Steel Tired and Chilled Wheels—Maximum durability, maximum strength, maximum retarding effect consistent with these.

Reinforced Steel Insert (Herron) Coach Shoe—Maximum strength, maximum durability.

HEAVY VERTICAL BORING MACHINE.

The Bentel & Margedant Co., manufacturers of wood-working machinery, have placed on the market a six-spindle car boring machine which is designed for the heaviest work in car shops and ship yards. The boring spindles shown in the accompanying illustration of this machine are each driven by an independent belt and will take augers up to 3½ ins. in diameter. This allows any of the spindles to be thrown out of motion when desired and gives a greater amount of power as no idler pulleys are used. The spindles have a vertical movement of 14 ins. and are adjustable back and forward across the width



Six-Spindle Vertical Car Boring Machine.

of the table with a range of 16 ins. In addition to these movements the two outside spindles have a radial motion in either direction for boring angular holes. An automatic traveling table of any desired length from 10 to 40 ft. rests and moves on the top of large rollers placed at intervals in heavy housings. These housings all run in dove-tail slides and are adjusted by means of screws and hand-wheels. The feeding of the table is done by a heavy pinion running in a rack and driven in either direction by reversible friction pulleys. For short distances and work requiring accurate setting, a lever ratchet hand feed is provided for feeding the table. The address of the Bentel & Margedant Co. is Hamilton, Ohio.

THE NORWOOD SYSTEM OF BALL BEARINGS AND CENTER PLATES.

It was noticeable at the Saratoga convention this year that more than the usual amount of attention was paid to car side bearings and center plates. This was apparent in the number of devices exhibited and in the interest which they aroused. Among these exhibits was that of the Norwood system of ball bearings, of the Baltimore Ball Bearing Co., Baltimore, Md. The special features of the exhibit last year was the suspension of the balls to keep them free from dirt and the side rolling movement, to prevent the balls from wearing flat. We are informed that these bearings are giving good results.

This year the Norwood Diamond Center Plate and Side Bearing were brought out. In this improvement four bearing points are provided for each ball because of the V-shaped channels in which the balls run. The diamond formed by these grooves gives the name to these devices. The bearing points determined by these channels prevent all motions except those in rotary directions, and lost motion is eliminated.

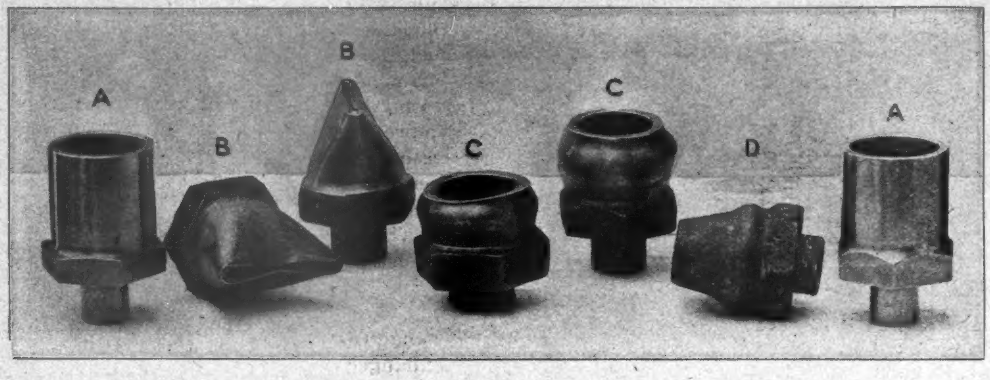
It is the elimination of the resistance of the trucks to turning that the most important claims for these bearings are made. It is held by these manufacturers, and this seems to be the tendency of opinion among railroad men, that by supporting the weight of a car permanently upon three points at each end, instead of upon the center plates only, that much lighter bolsters may be used. In the case of the large number of old cars now in service this will be a source of considerable saving, and in many cases improved side bearings may be the means of saving the cost of new bolsters. It is also obvious that a considerable saving in flange and rail wear will accompany the introduction of this improvement, and that the danger of derailment will be greatly reduced.

An important feature of this construction is the method of making the bearing frames, which may be used over and over again with the renewal of the wearing plates at a trifling cost. This company also proposes to make steel bolsters in which the wear from all sources will come upon renewable plates. It is obvious that the advantages here outlined apply equally well to passenger and freight cars.

Concentrated information concerning the various departments is required for the management of the enormous manufacturing enterprises of the present time. No one could manage such a colossal concern as the new steel corporation, involving hundreds of plants, fleets of ships, ranges of iron ore and miles of railroads, without a daily report of boiled down information. We are told that the General Electric Company has at Schenectady a substantial printing establishment where every night a report of the affairs, progress and status of each department concerning the work in hand is prepared for appearance each morning upon the desks of the heads of the departments. This is a striking example of present methods of manufacturing.

TROPENAS STEEL OIL CUPS.

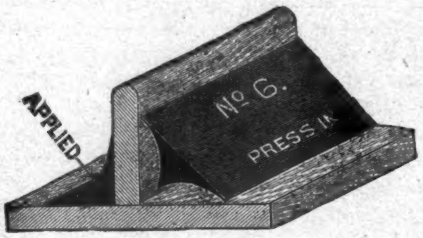
The castings shown in the accompanying engraving in the form of oil cups are the most recent products of the Sargent Company, of Chicago. These cups are made by the Tropenas steel process, which produces a casting that is exceedingly tough and in cost is very reasonable. They are made in any size and shape, and with the addition to the company's Tropenas department which is now under way, a large line of these high-grade castings will be kept in stock so that orders can be filled promptly. The engraving illustrates the toughness of the metal. A and B are the normal shapes, the others being distorted to test the metal.



The Sargent Company's Tropenas Steel Oil Cups.

"PERFECT" LEATHER FILLET.

The leather fillet manufactured by A. G. Butler, and shown in the accompanying engraving, is constructed with curved sides which form a perfect arc of a circle when applied. With ordinary fillets considerable time is lost in tacking and clamping, and also in the use of the mitre box. All these difficulties are dispensed with by the use of the leather fillet, and can be easily and quickly applied on single or compound curves and on straight work. They are not affected in the least by heat, cold or moisture, and their application is accomplished by a single operation. The address of the A. G. Butler Company is 285 Pearl street, New York.



Leather Fillet with Curved Sides.

An Old Locomotive at Barrow.—The Furness Railway Company in 1899 were possessed of the oldest working railway engine in the world. This engine, which is known as "Copper Knob No. 3," has been put out of service, and the company in question now propose placing it in an open building in the front of the Barrow Central Station as a memento of the early days of the railway in Furness. The engine was purchased from Messrs Bury, Curtis & Kennedy, of Liverpool, in 1846, and was thus running passenger and goods trains on the Furness railway for over 50 years. The boiler is 3 ft. 8 ins. in diameter and 11 ft. 2 ins. long, and the whole engine weighs about 19 tons. The local term "copper knob" is applied to the engine on account of the round back fire-box, the dome of which is covered with copper.—The "Mechanical Engineer."

IMPROVED LEVER THROTTLE VALVES.

In this newly improved form of valve made by the Wm. Powell Company, of Cincinnati, the construction is entirely different from all former makes of throttle valves. It is strong, durable and so nearly frictionless that its operation is very easy. In the accompanying engraving, Fig. 1 illustrates

Fig. 1.

the exterior form of the body and Fig. 2 the interior working parts of the valve. The operation of this very ingenious device for opening and closing the valve is best shown by reference to the lettered parts, of which B is the spindle, C the carrier terminating in a tapering wedge, D, and F F are two

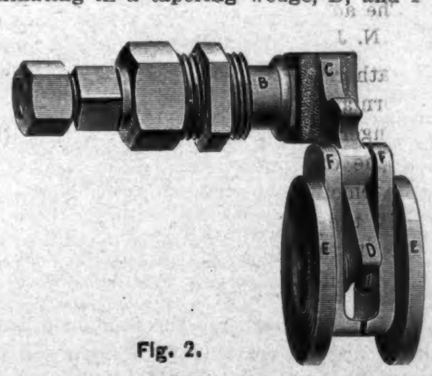


Fig. 2.

links loosely coupled to the carrier at its upper end, while the lower ends of the links engage the studs of the disks, E E. The upward movement of the carrier, C, first lifts the wedge from between the disks before they begin to move, and as the disks fall loosely away from their seats they are carried up to full opening without friction on the seats. In the downward stroke the wedge, D, performs its work upon the disk studs as the rotation of the spindle reaches a dead center. These valves are made in bronze from ½ to 3 ins., and in iron from 1 to 8 ins., and the parts are all interchangeable. The company manufactures two grades of these valves, the "Titan" and "Giant." The latter is designed for high working pressures.

EXHIBIT OF THE AMERICAN BLOWER COMPANY AT THE PAN-AMERICAN EXPOSITION.

In Block No. 26 of the Machinery Hall is an exhibit of heaters, engines, blowers, dry-kilns trucks and kindred other machinery, which is quite interesting and well worth the few minutes' time necessary to inspect it by anyone who has use for such machinery. Almost everyone is interested in this particular line as these devices enter into almost all branches of manufacture in some way or other. The booth is about 20 feet in height, and topped by a gable-end resting on some very prominent columns. Above this is a large painting emblematical of the American Blower. The general scheme is rendered in ivory white and deep green. Another feature which attracts a great deal of attention is a model of the widely-known and very successful "Moist-Air" dry kiln. This model has a glass side, enabling the spectator to see the exact operation of the kiln.

Besides a large 140-in. full-housed steel plate fan driven by an 8 by 8-in. marine type vertical engine, coupling direct to the fan shaft is a Moorhead automatic return steam trap in operation, which clearly shows how the trap drains condensation from heating surfaces and delivers it direct to the boiler.

There is a large pressure blower mounted on a Z iron base, on the other end of which is the vertical automatic high-speed engine which drives it. They are also showing a horizontal automatic high speed engine and a vertical low-pressure engine, as well as their well-known A.B.C. exhaust fans.

The exhibit is well worth investigating and the company assures a cordial welcome to all who will make this exhibit their headquarters.

The first thing an interested person wishes to know concerning the discussion of a subject before the Master Mechanics' or Master Car Builders' Associations is the opinions of the organizations as expressed in the proceedings. It is not always possible to put these in the form of resolutions such as "the sense of the meeting," but it would be well to cause the discussions to be reviewed by a regularly appointed individual or committee who would review the discussion on each subject. The object is to present the conclusions drawn from the report papers and remarks in the form of an exceedingly brief statement to be voted upon by the entire association as representing the opinions of the body as to those subjects. The custom of the International Railway Congress in this respect is an interesting example of this idea. Each section, after a discussion, draws up a resume which is a condensed statement of the general drift of the discussion and this is placed on record by the entire organization as representing the views expressed and the tendency indicated by the remarks. In a very short time anyone may obtain from these conclusions an excellent idea of the status of each question brought before the congress last year. Without such a system it would be necessary, at a great expense of time and patience, to go through the voluminous reports. This idea carefully carried out would add immensely to the value of all the technical railroad and engineering organizations.

BOOKS AND PAMPHLETS.

"Burlington's Number One."—This is the title of a pamphlet of unusual artistic merit recently issued by the Passenger Department of the Chicago, Burlington & Quincy Railroad. It describes their train No. 1, a fast express running every day between Chicago and Denver, equipped with every modern convenience that adds to the comfort of the tourist. Mr. T. K. Hanna, Jr., has pictured in this booklet in a very pleasing manner the accommodations of the sleeping, chair, buffet and dining cars and the unusual accuracy in the details of these illustrations adds greatly to the attractiveness of the book. Mr. P. S. Eustis is the General Passenger Agent of the Burlington road. His address is 209 Adams street, Chicago.

Air Compressors.—The New York & Franklin Air Compressor Companies have sent a complete catalogue of their air compressors for operating pneumatic tools in shops, foundries, shipyards, mines, tunnels, quarries and for every service to which compressed air is applied. This catalogue B illustrates and describes nine different classes of compressors actuated by steam, belt, gearing, electricity or water power. It also gives some useful information regarding the comparative economy of air compressors, the selection of air compressors and the careful installation of compressed air equipment. The company in presenting this pamphlet also announce the commencement of operations in their new works at Franklin, Pa., which are modern and in every way the most proficient for the purpose of manufacturing air compressors. Their main offices are at 95 Liberty St., New York.

Boilers.—A new catalogue of corrugated furnace boilers with the Morison suspension furnace for marine and stationary use has just been issued by Joseph T. Ryerson & Son, Chicago. This corrugated furnace boiler has a very wide field of usefulness, as is shown by the catalogue, which gives in addition to the brief description of the principal features of these boilers some extensive lists of places where they are in use, and what people think of them. Their application is shown in a few instances by engravings, among which is an application of the Morison furnace to the locomotive designed by Cornelius Vanderbilt; also the design of a return flue type of locomotive boiler with Morison furnace, designed by John Player, of the A. T. & S. F. Railway. This small volume, No. 4, of the Ryerson technical library may be had by addressing Joseph T. Ryerson & Son, Chicago, Ill.

Purdue Society of Civil Engineering.—The proceedings of this society for the year 1900-1901 have been received. This, the fifth annual number of this publication, contains several creditable papers by members of the Civil Engineering class on the following subjects: Some Modern Creosoting Plants, Concrete Leveling, The American Society of Civil Engineer's Rail Section, The Equipment and Management of an Engineer's Field Party, Simple Solution of Compound Curves, Timber Beam Diagrams and Masonry Diagrams. Also a paper on The Errors of the Transverse Surveys by Prof. W. D. Pence. The price of this volume is 50 cents.

The June, 1901, issue of the Iowa Engineer, a quarterly publication devoted to the interests of the engineering departments of the Iowa State college, is an exceptionally strong number. It contains several carefully selected papers which cover a wide range of the engineering field.

"Jim Skeevers Object Lessons."—The American Brake Shoe Company has published for its licensees, the Sargent Company, the Ramapo Foundry Company and the Railway Appliances Company, a limited edition of this popular and instructive series of stories of railroad motive power work for distribution among its friends. In these "Object Lessons" Mr. John A. Hill has put into very readable form a rather severe but not unmerited commentary upon methods of managing motive power matters and the book deserves a place in the libraries of all operating officials. One who reads the first of the stories is not likely to leave the others unread and they cannot be read without pleasure and profit. This edition is attractively printed and well bound. The edition of 300 copies will doubtless be far from enough to supply the demand.

Locomotives of the Nineteenth and Twentieth Centuries is the title of the latest number of the Record of Recent Construction of the Baldwin Locomotive Works. This valuable series of pamphlets contains many good chapters of the record of the locomotive and the one now at hand is specially worthy of thoughtful consideration. It contains the address of Mr. S. M. Vauclain, read before the New England Railroad Club last February. The early history of the locomotive was followed by aid of lantern slides prepared by Mr. J. G. Pangborn. The comments of a man of Mr. Vauclain's standing upon the probable future of the locomotive are specially worthy of attention and it is encouraging to note that he believes that the near future will bring out important developments. This pamphlet is prepared in excellent taste and is well worthy of permanent preservation.

The Santa Fe Route has just issued an illustrated pamphlet of the Pan-American Exposition and a folder containing a panoramic view of the Grand Canyon of Arizona. On the back of the folder are a number of interesting facts about the canyon, how it is most easily reached, something about hotel accommodations and a few impressions from people who have seen the Grand Canyon. The Pan-American pamphlet illustrates and describes many of the features of the exposition and how to see them; it also gives valuable suggestions to those traveling from Mexico and the Southwest to Chicago over the Santa Fe Route.

"Fire Hose," "Rubber Belting" and "Rubber-Covered Rollers" are the titles of three catalogue pamphlets received from the Boston Belting Company, 256 Devonshire street, Boston. The first contains illustrated descriptions of the various kinds of fire hose made by this company, including accessories, such as nozzles, fittings and hose racks. It also includes pertinent remarks concerning requirements and underwriters' regulations. The second contains a chapter of facts relating to rubber belting derived from an experience of more than 70 years as manufacturers. This is followed by suggestions for the transmission of power by rubber belting and a statement of the conditions most favorable to the use of rubber. Besides illustrating Forsyth's patent seamless belting and other varieties of their manufacture, the pamphlet includes several pages of valuable information and rules which will be convenient to all belt users. The third pamphlet deals with rubber-covered rollers which are made in great variety for industrial purposes. These rubber coverings are applied by a process invented by Mr. J. B. Forsyth, General Manager of the Boston Belting Company. The catalogues are standard size (6 by 9 ins.) and are admirably printed and illustrated.

Continuous Rail Joints.—The Continuous Rail Joint Company of America have produced an excellent catalogue of their rail joints, including joints for T rails, girder rails, "compromise" and insulated joints. The engravings, which are excellent, illustrate joints for eleven A. S. C. E. standard sections, twelve other sections, including the "Manning," "Dudley" and P. R. R. sections, ten girder section joints and two "compromise" joints for joining T and girder rails. The insulated joint is illustrated in connection with an 85-lb. section of the A. S. C. E. standard and we judge that the substantial support given to the joint by its form will relieve the signal engineer from a great deal of worry concerning insulations whereever these are used. The object of the continuous rail joint is to overcome the admitted defects of the ordinary angle bar and permit of overcoming the usual weakness at the rail ends and at the same time to return all of the advantages of the angle bar. The result is an angle bar and base plate in one piece and a joint which takes the form of a sleeve. This is, however, too well known to require description here. In the catalogue the right-hand pages have full-sized sections of the joints and opposite each of these is a terse paragraph outlining the advantages of this construction. This company is prepared to furnish joints to fit any rail section. The address of Mr. L. F. Braine, General Manager, is Newark, N. J.

Cheaper Than Shoe Leather.—The Santa Fe keeps a neatly bound book on its California Limited train called "The Log Book," and in this passengers record their observations and impressions of the trip, the excellence of the service, etc.—sometimes a bit of verse, sometimes a note of approval of the dining-car service. One of the latest and best of these paragraphs is given below. In it the writer demonstrates (to his own satisfaction at least) that it is cheaper to ride on the Cal-

fornia Limited than to walk. "The California Limited, May 30, 1901. San Francisco to Flagstaff, 855 miles, fare and sleeper $36.40, meals and extras $3.60, total $40; cheaper than walking. Walking at 20 miles per day, 43 days: Meals 25 cents, lodging 25 cents, total $43. We ride first class, save 41½ days, save shoe leather, save clothes and save $3. Who would not ride on the California Limited?"

McGill College and University has sent its 1901-1902 catalogue, which is a volume of 384 pages giving a general description of the courses that are offered in Arts, Applied Science, Law, Medicine, Veterinary Science, together with detailed information regarding the admission of students and the requirements.

EQUIPMENT AND MANUFACTURING NOTES.

The Cleveland, Cincinnati, Chicago & St. Louis Railway is using draft springs of larger capacity than the M. C. B. spring, but of the same outside dimensions. These springs have three coils which fit closely one coil within another. The outer coil tested alone to 6 ins., requires a pressure of 16,700 lbs.; the second coil alone, 5,400 lbs., and the inner coil alone, 1,400 lbs. Compressed separately to 6 ins., the coils thus have in all 23,400 lbs. capacity, but when assembled, a little over 28,000 lbs. is required to compress the group to 6 ins. The difference is accounted for by the friction of one coil on another. This is mentioned here as showing how the capacity of a spring of the standard dimensions can be increased.

An order for new passenger equipment for the Wabash Railroad includes two baggage cars, eight combination passenger and baggage cars, thirty coaches, ten reclining chair cars, three cafe and two dining cars. Four of the combination cars, ten of the coaches and all of the chair cars, cafe and dining cars will be 70 ft. in length with wide vestibules. They will have the Martin stationary vestibule, standard six-wheel trucks, and all trucks will have steel wheels. The finish will be selected mahogany and quartered oak, but the finer cars will have selected St. Jago mahogany and the half empire deck. The lighting will be with Pintsch gas for all the ordinary cars, but for the cafe and dining and chair cars they will have the finest of electric light equipment. The dining cars will seat twenty-nine persons, with ample kitchen space; the cafe will seat eighteen persons, and will have a library and smoking room in the observation end, which will seat fourteen. Another up-to-date feature will be a private dining room for eight persons.

Northern New England is one of the most attractive summer pleasure and vacation grounds in the world. No other section can boast of scores of lakes, a hundred beaches and a whole mountain range within the meagre boundaries of a hundred miles square, yet this is what New England has, and, though there are thousands of tourists annually at these resorts, there can be accommodated hundreds of thousands more. Every nook and corner of New England is an outing resort and the Boston & Maine lines reach all of the leading ones. If you are interested in or intend to take a vacation this season you want a Boston & Maine Excursion Book. Send a postal to the General Passenger Department of the Boston & Maine Railroad, Boston.

A handsome "convertible" car forms a part of the exhibit of the J. G. Brill Company at the Pan-American Exposition. It is 28 ft. long and is equipped with the ingenious sliding panels which may be pushed up into the roof, making an "open" car or drawn down between the posts, making it an equally satisfactory "closed" car for winter service or for stormy weather in the summer season. The seats are of the walk-over pattern with an aisle between them. This is not only a very creditable exhibit, but it marks a high attainment in street car construction, for electric lines are rapidly progressing in a direction which must ultimately interest, if it does not instruct, those who are conducting the suburban service of steam roads. The car referred to is mounted on a pair of Brill "27 G" trucks.

Mr. Frederick Brotherhood has been appointed Manager of the Foreign Sales Department of The Railroad Supply Company, with headquarters at their New York Store, 106 Liberty Street.

The Monarch Brake Beam Company, Limited, of Detroit, state that the Waycott-Andrews Supply Company is no longer connected with them in any way.

Mr. Henry W. Toothe, who for a number of years represented the Midvale Steel Company and later the Chicago Pneumatic Tool Company, has taken charge of the Railway Department of the Magnolia Metal Company as sales agent, with headquarters in New York. Mr. Toothe's wide acquaintance and his thorough knowledge of the railroad requirements will make his services invaluable and this fact, with the high standing of this company and its product, lead us to congratulate both parties.

The Pan-American Exposition exhibit of the Baldwin Locomotive Works is described in a pamphlet of 32 pages. Four locomotives are exhibited, a heavy consolidation freight engine for the Lehigh Valley, a 10-wheel passenger engine with Vanderbilt boiler and tender, for the Illinois Central (see American Engineer June, 1901, page 205); a consolidation freight locomotive with a moderately wide firebox for the Buffalo & Susquehanna Railroad and an electric mining locomotive of 50 horse-power for the Berwind-White Coal Mining Company. In addition to detailed information of these engines the pamphlet describes the Baldwin Locomotive Works and contains a striking statement of their capacity. It is printed in parallel columns in English and Spanish.

The creative genius apparent in the architecture of the many buildings of the Pan-American Exposition is without equal and the effects obtained through the beautiful color decorations the most pleasing. The exhibits are well chosen and compare favorable with all other expositions. The landscape work has developed the grounds into a place of great delight. Buffalo, as a city, is a very fascinating place, and excursions can be made in every direction to localities intensely interesting, but the greatest attraction save the Exposition is Niagara Falls, which is truly one of the marvels of the world. The Boston & Maine Railroad is making every inducement possible for the benefit of the tourist to Buffalo from New England. The rates are the lowest, the routes numerous, the line the most direct and its trains the best equipped of any from Boston. The General Passenger Department of the Boston and Maine will upon application send a Pan-American folder which is full of information that will be of service to those visiting the Exposition.

A record shipment of steel cars left Pittsburg July 20 from the works of the Pressed Steel Car Company over the Baltimore & Ohio Railroad. The shipment was made to the Great Southern of Spain Railroad in Aquiles, south Spain, and comprised a solid train of thirty-two cars. The contents of the train was seventy large capacity pressed-steel hopper-ore cars, carefully packed in parts for shipment on the White Star Line steamer Georgic, which sailed from New York July 23. An engineer from the Pressed Steel Car Company will superintend the erection of the cars on their arrival in Spain.

The cars themselves are of 80,000-pounds capacity, and when in service will be the largest cars in use on any Spanish railroad. In some respects they differ materially from American cars. For instance, one car in ten is equipped with a shelter box for the brakeman or guard. These boxes are built of wood on the end of the car, and are so constructed that the guard has an unobstructed view of the portion of the train under his care. Other minor portions of the car, such as the hand-brake apparatus, etc., differ from American standards, but in the main the cars are similar to those built for ore roads in this country. The cars when erected will be 26 ft. 6¾ ins. long, 8 ft. wide with a height, from top of rail to top of body, of 9 ft. 9½ ins. The light weight is 29,180 lbs., and the ratio of paying load to total weight of car when loaded 75.09 per cent. The gauge of the Great Southern of Spain Railroad is considerably wider than our standard, being 5 ft. 6 ins.

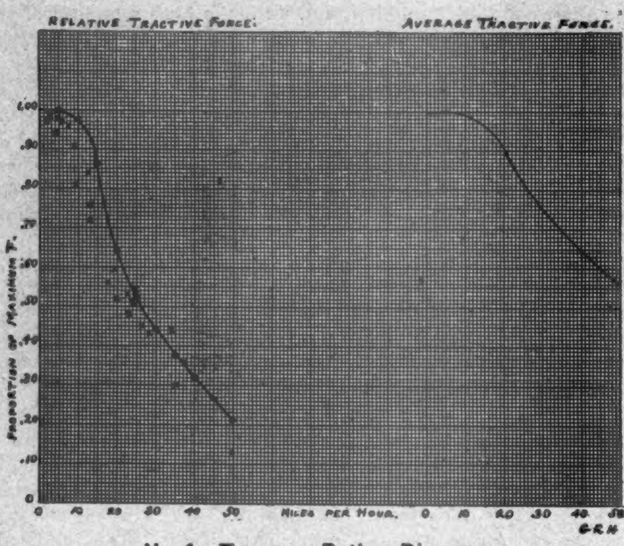
MASTER MECHANICS' AND MASTER CAR BUILDERS' REPORTS, CONCLUDED FROM JULY.

PRACTICAL TONNAGE RATING.

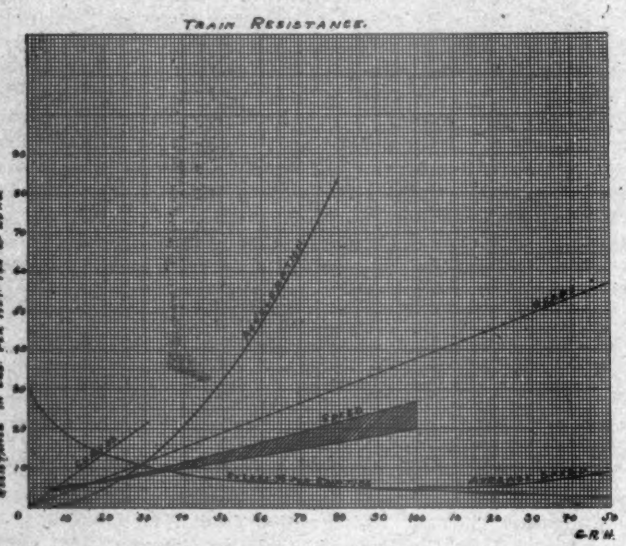
By George R. Henderson.

[A Paper Read Before the American Railway Master Mechanics' Association.]

In 1898 the writer was chairman of a committee which reported to this Association on the subject of Tonnage Rating for locomotives. In this report it was stated that the committee believed that results could generally be secured more quickly and satisfactorily by first producing the theoretical rating and checking this up by practical tests. How far the theoretical rating will be satisfactory depends upon the care and foresight used in determining it. The committee above referrred to presented a number of diagrams and formulae for use in such work, but when there is much of this to be done the calculations of the various cases require a great deal of time, particularly when momentum grades and many sizes of locomotives must be considered. In fact, the writer remembers a case several years back when it occupied a force of six men for ten days to rate thirteen classes of engines over 1,500 miles of road, and this without considering momentum grades. With 5,000 miles of track and 75 varieties of locomotives, the former methods would be almost prohibitive, and this has led to the adoption of new methods by which an ordinary division of say 500 miles can be rated in from three to five hours, and for all the locomotives in service, the rating to be practically correct for momentum grades as well as "dead pulls." Empties and "time freights" may also be included with no extra labor, and thus a new division, heretofore unoperated, may be scheduled before the equipment is placed upon it. Of course there will always be cases where an increase in the speed of approach to a grade will permit a heavier rating, but it is a very easy matter to make slight variations in the schedule.

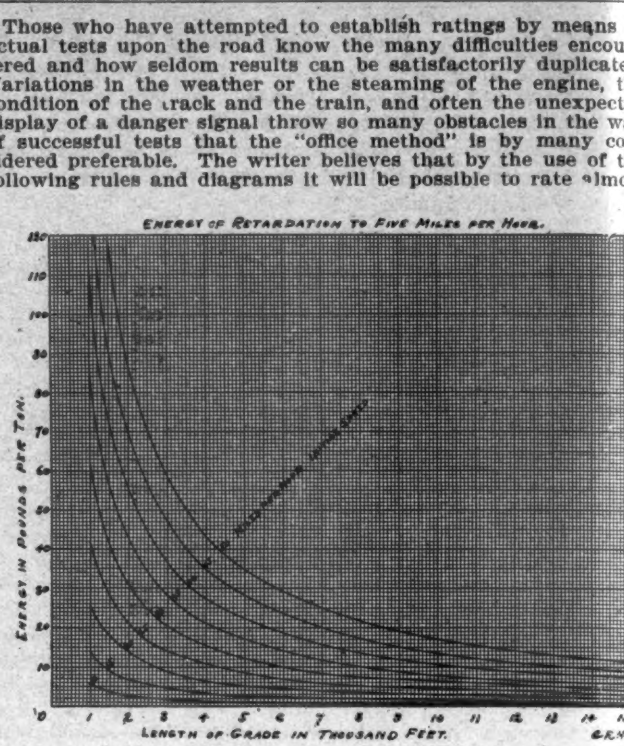


No. 1.—Tonnage Rating Diagram.

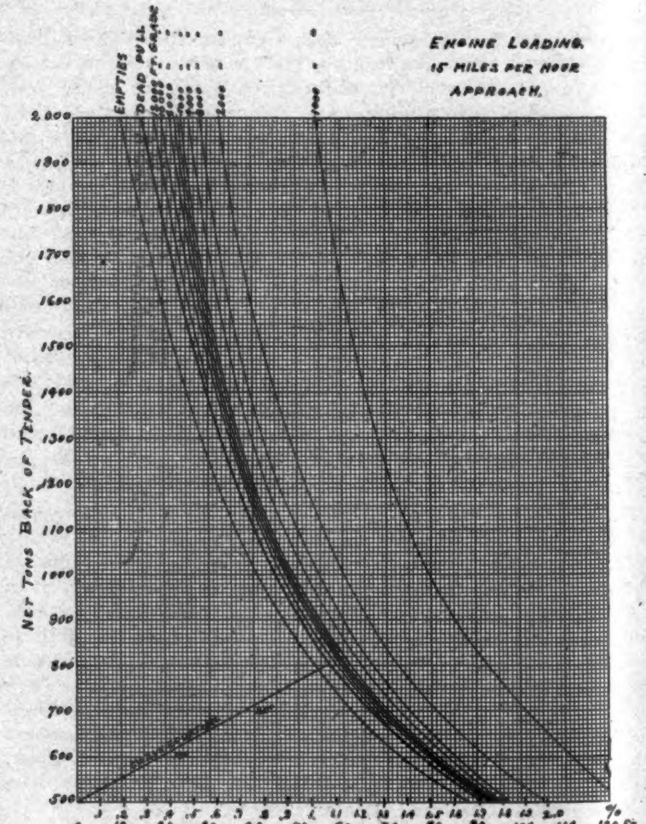


No. 2.—Tonnage Rating Diagram.

Those who have attempted to establish ratings by means of actual tests upon the road know the many difficulties encountered and how seldom results can be satisfactorily duplicated. Variations in the weather or the steaming of the engine, the condition of the track and the train, and often the unexpected display of a danger signal throw so many obstacles in the way of successful tests that the "office method" is by many considered preferable. The writer believes that by the use of the following rules and diagrams it will be possible to rate almost any modern engine on any profile and alignment, and with very few calculations to establish a satisfactory schedule.



No. 3.—Tonnage Rating Diagram.



No. 4.—Tonnage Rating Diagram.

Tractive Force of Locomotives.

The tractive force referred to in this article will be that available at the circumference of the drivers, and will be designated by T, and is determined as follows:

At slow speeeds, 5 to 8 miles an hour, with the reverse lever in the corner notch and a cut-off of about 90 per cent. of the stroke, pressures will be obtained about as follows:

Initial pressure	=.95 boiler pressure.
Mean effective pressure	=.91 initial pressure.
Mean effective pressure	=.86 boiler pressure.
Allowing 8 per cent. internal friction........	=.92 M.E.P.
Mean available pressure	=.80 boiler pressure.

This allows for friction of pistons, valves, eccentrics, etc., but not the resistance to motion which must be considered with the train. For the maximum available tractive force we have for single expansion engines:

$$T = \frac{p\,d^2\,s}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where p = mean available pressure in lbs. per sq. in.
d = diameter of cylinder in inches.
s = stroke in inches.
D = diameter of driver in inches.

We can also write:

$$T = \frac{.8\,P\,d^2\,s}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where P = working boiler pressure in lbs. per sq. in.

For 2-in-cylinder compounds, when operating compound:

$$T = \frac{.8\,P\,d_l^2\,s}{D\,(r+1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where d_l = diameter of low-pressure cylinder in inches, r = ratio of cylinder volumes.

For 2-cylinder compounds when operating simple:

$$T = \frac{.8\,P\,d_h^2\,s}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where d_h = diameter of high-pressure cylinder in inches. (This, of course, assumes that the adhesion of the engine is sufficient to allow it to develop this tractive force without slipping.)

Four-cylinder compounds will give values as follows:

When operating compound:

$$T = \frac{16\,P\,d_l^2\,s}{D\,(r+1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

And when operating simple:

$$T = \frac{16\,P\,d_h^2\,s}{D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

While variations in these figures may sometimes be looked for they will generally represent safe deductions at the slow speed mentioned above.

As the speed is increased the value of T will evidently be reduced, as the boiler is generally inadequate to maintain full pressure with the lever in the corner over 5 to 8 miles per hour. In order to determine the possibilities in this direction tests were made with a dynamometer car and also by means of the Chicago & Northwestern Testing Plant, the standard 10-wheel freight engine of that road being taken for this purpose. This locomotive has the following proportions:

Cylinders (single)	20 by 26 ins.
Driving wheel diameter	63 ins.
Steam pressure	190 lbs.
Tube heating surface	2,146 sq. ft.
Firebox heating surface	186 sq. ft.
Total heating surface	2,332 sq. ft.
Grate area	29 sq. ft.
Total cylinder volume	9.5 cu. ft.
Ratio of grate area to cylinder volume	3
Ratio of heating surface to cylinder volume	245
Ratio heating surface to grate area	80
Weight on drivers	118,350 lbs.
Weight of engine and tender	130 tons
T (max.)	25,000 lbs.

Diagram No. 1 shows the relative tractive force at different speeds. The curve illustrates the results derived from records obtained on the "testing plant" and the crosses are plotted from the dynamometer car experiments. Thus it will be seen that the test-plant gave generally the maximum T, as might be expected. In order to simplify the calculations, it is more convenient to consider the average T during the period of retardation, and the right-hand curve on diagram No. 1 gives the average T during a reduction from the speed designated by the abscissa to 5 miles per hour. The two curves of diagram No. 1 therefore present a ready means of obtaining the tractive force for a fixed or variable speed. (Of course, a large increase in the proportions of boiler to cylinder will give curves having greater ordinates for the corresponding abscissae than those shown, which are based on the class R engines as stated above.)

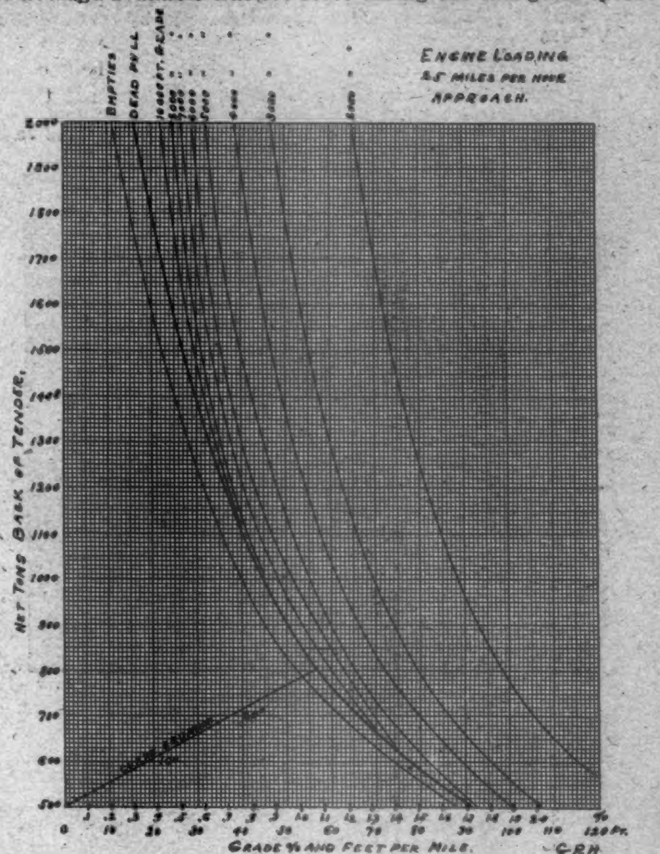
Resistance of Train.

Diagram No. 2 gives the curves for train resistance in accordance with the "Engineering News" and the Baldwin Locomotive Works formulae, being respectively $= 2 + \frac{V}{4}$ and $3 + \frac{V}{6}$, where V equals velocity in miles per hour, and the shaded portion of the zone shows the variation in resistance that may be met with. (In this diagram, the abscissae represent the unit of grade, speed, etc., and the ordinates the resistance.) For grades we have resistance = .38 M when M = the feet rise per mile.

Curves give a resistance equal 0.7 c, where c = degree of curvature. Acceleration (and retardation) a resistance = $0.0132\,A^2$ when A = speed attained in one mile, in miles per hour. (The latter includes rotative energy of the wheels and axles.) The "average speed" curve is used for varying speeds and gives the average resistance between the selected speed and five miles per hour.

Effect of Momentum.

By utilizing the momentum of retardation we are enabled to pull much heavier trains up a grade than we could with a dead pull only. The effect of this is to produce a virtual grade, which is less steep than the actual grade, and the weight of train which can be pulled corresponds to this virtual grade. It must be remembered, however, as illustrated in Diagram No. 1, that at high speed the tractive force of the engine is reduced, and when we desire to figure momentum grades we must calculate on the average available tractive force during the change of speed



No. 5.—Tonnage Rating Diagram.

No. 6.—Tonnage Rating Diagram.

from that at the foot of the hill to, say, five miles per hour at the top. The relation of this to the maximum T can be found from the right-hand curve of Diagram No. 1.

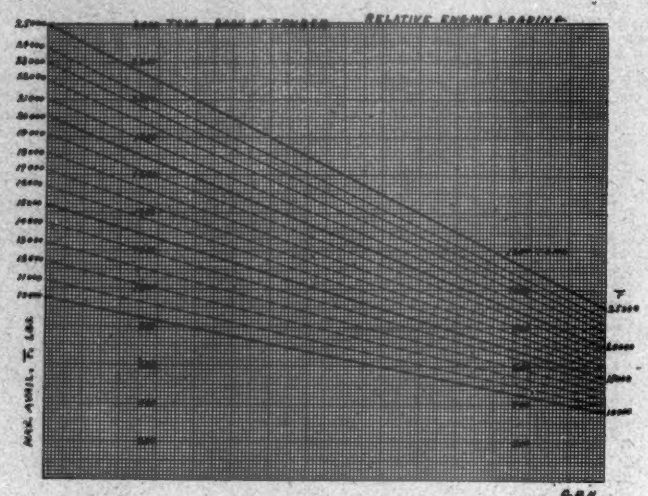
The average resistance to speed may be taken from Diagram

No. 2 and the resistance due to actual grade from the same chart. This resistance, however, is to be reduced by the amount of inertia due to retardation of train from the maximum speed to five miles per hour. The average force of inertia in pounds per ton may be expressed approximately by the formula, $70\frac{V^2-25}{x}$, where

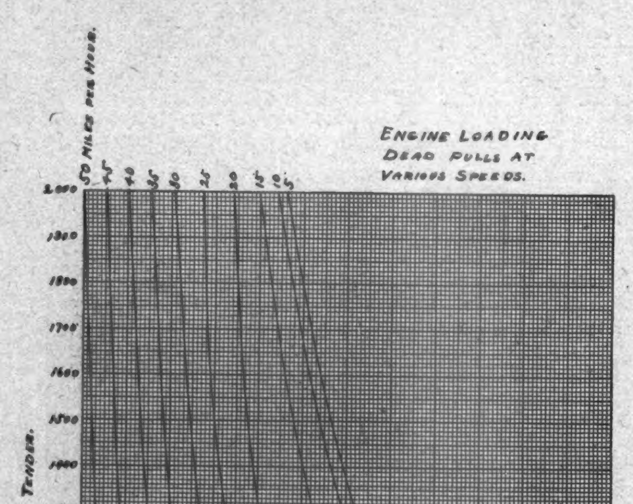
V = initial velocity in miles per hour.

x = distance traversed during retardation, in feet.

Diagram No. 3 gives a series of these curves for various values



No. 7.—Tonnage Rating Diagram.



No. 9.—Tonnage Rating Diagram.

of V and x when speed is reduced to five miles per hour. This energy added to the average T represents the propelling force, and the sum of the various resistances gives the amount to be overcome by the first two forces. The equation must, of course, be made for the total weight of train multiplied by the various coefficients in pounds per ton, as the tractive force is also in pounds; as, for example, to find the weight of train, divide the average tractive force by the sum of the coefficients for grade and average speed minus the coefficient for energy due to retardation. The weight of the engine and tender must be deducted for net loading.

Effect of Empty Cars.

It has been suggested from results of experiments that an empty car has about 1.8 lbs. greater resistance per ton than a loaded car at slow speeds. If we wish to express this as a percentage of increase over loaded trains we can use the formula for this excess $\frac{1.8}{y+}$, where y = resistance due to grade. The locus of the formula is drawn on Diagram No. 2 where the ordinate gives the excess resistance in per cent. for empties on the grade in feet per mile represented by the abscissae. Thus empty trains should be considered as having so many per cent. greater tonnage than actually the case, depending upon the grade to be ascended.

Method of Rating Engines.

The various rules enumerated above are embodied in Diagrams Nos. 4, 5 and 6, which give the tons behind tender which a Class R engine can pull on various grades. The heavy line gives the rating on a dead pull for grades of the ascent shown by the abscissae. The line marked "empties" gives the rating for empty cars.

In Diagram No. 4 the upper fine lines give the load for a speed of approach of 15 miles per hour, reducing to five miles per hour at top, and length of grade being denoted by figures at top of line. These allow for the effect of momentum and the diminished T at the higher speed. The short line at lower left-hand corner gives the ratio for equating curves and grades; thus, add to the actual grade the grade corresponding to the curvature shown for the total effective grade. For empties operated under momentum rules, from the intersection of tonnage line and "dead pull curve" follow directly down to the "empty" line, which gives the empty rating for the corresponding case. Diagram No. 5 gives the same data for a speed of approach of 25 miles per hour, and Diagram No. 6 at 35 miles.

To illustrate: The engine selected as the standard can haul 1,750 tons up a 21-ft. grade in a "dead pull." On a 34-ft. grade with a dead pull, 1,250 tons would be the limit. However, on a hill of this grade 9,000 ft. long and with a 35-mile an hour velocity at the foot, 1,450 tons can be taken up. If empties compose the train, 1,300 tons would be the allowance. By this means it is easy to rate the "standard engine" over the whole road. In order to simplify the rating of other classes, we have recourse to Diagram No. 7. This gives the load suitable for an engine having a different T when the load for the "standard" engines is known. These lines are not radial as would seem at first sight, but are parallel to radial lines whose tangents are proportional to the T of the different engines, the parallel being drawn below the radial lines by the amount corresponding to the weight of engine and tender. In this way, the loads back of tender are comparable by the diagram, whereas it would be the power at the drivers were the radial lines used. The diagram is drawn for other hypothetical engines to compare with the standard, assumed engine and tender weights being allowed, and it being further supposed that the boiler has about the same proportions relatively to the cylinder power.

Diagram No. 8 and the following table are reproduced from one of the Division Time Cards of the Chicago & Northwestern, and explain fully how the chart is used.

Class "R" Ratings for Freight Trains—Wisconsin Division.

	Dead.	Time.	Empties.
Princeton to Fond du Lac	860	775	800
Fond du Lac to Princeton	1,260	1,140	1,150
Fond du Lac to Sheboygan	770	690	720
Sheboygan to Fond du Lac	930	840	870
Foud du Lac to Milwaukee (Helper Fond du Lac to Eden)	1,290	1,160	1,160
Milwaukee to Fond du Lac	1,060	960	970
Milwaukee to Chicago (Helper to Cudahy)	1,380	1,250	1,250
Chicago to Milwaukee	1,440	1,300	1,280
Green Bay to Appleton Junction	1,440	1,300	1,280
Appleton Junction to Green Bay	2,000	1,800	1,600
Appleton Junction to Fond du Lac	2,000	1,800	1,600
Fond du Lac to Appleton Junction	1,380	1,250	1,250
Fond du Lac to Janesville (Helper to Oakfield)	1,250	1,130	1,080
Janesville to Chicago	1,120	1,000	1,030
Chicago to Janesville	1,160	1,050	1,050
Belvidere to Kenosha	900	840	875
Kenosha to Belvidere	900	820	810

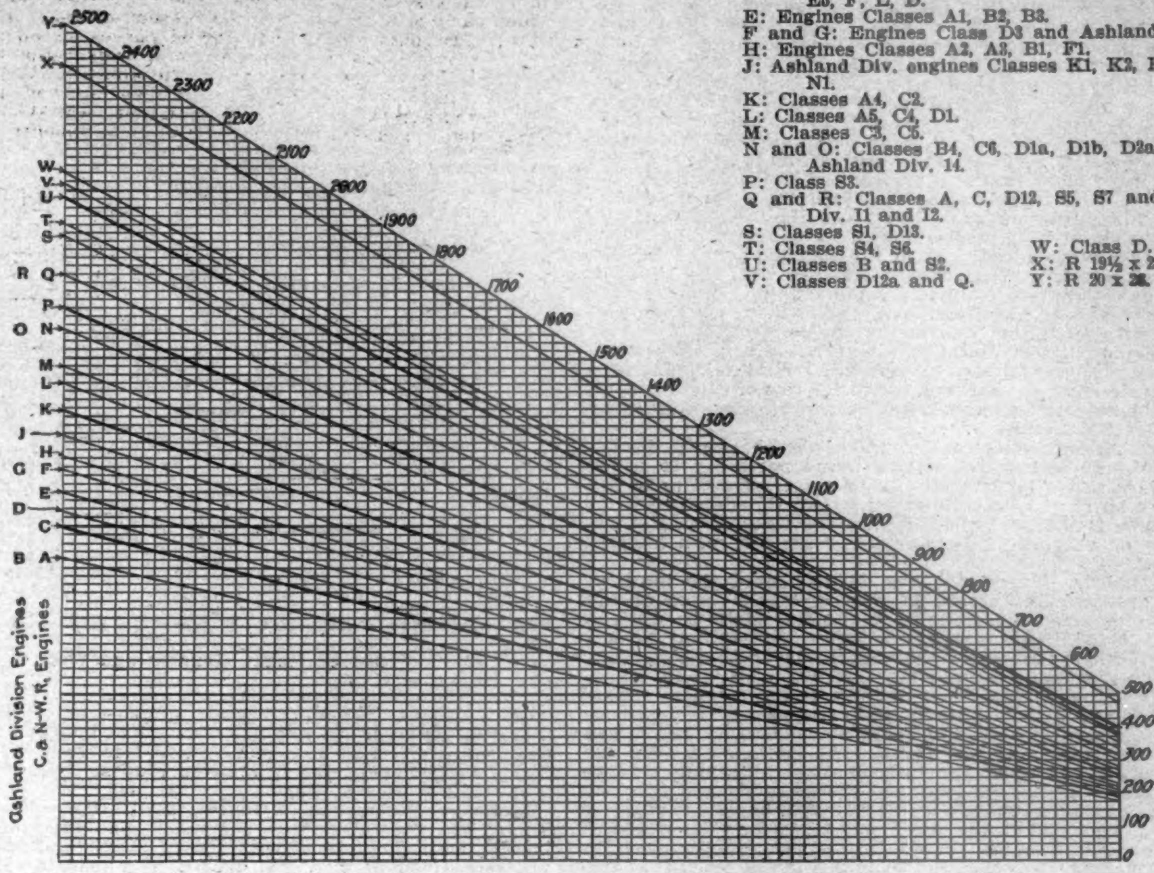
Rating for other than Class R engines will be obtained from diagram.

It is hardly necessary to say that an accurate knowledge of the profile and alignment is necessary to properly rate an engine, as well as the crossings, water tanks, stops and methods of operation, as these all contribute to the success of the rating.

The use of the Diagram No. 8 simplifies the transfer of engines from one division to another, as the proper loading can be determined by a glance at the diagram, when the class is known. For example, in the table given above the rating for Class R engine from Chicago to Milwaukee is 1,440 tons. On diagram No. 8 we follow down the vertical line corresponding to 1,450 tons on the upper diagonal line, and the intersection with the various diagonals gives the proper loading; for instance, Class Q, 1,160 tons; Class S-3, 950 tons, and so on. As all locomotives have the class letter painted on the cab, the proper rating is easily determined.

The ratings explained have been based on a speed of 5 to 8

miles an hour for a dead pull or for a summit velocity of 5 miles an hour for momentum runs. It will often be necessary to determine what load could be hauled at a higher speed, or what speed could be obtained with the same weight of train on a



References to Letters at Left of Diagram.

A and B: Engines Classes F2, H1, H3 and Ashland Div. A.
C: Engines Classes B5, E1, E4, E5, H4.
D: Ashland Div. engines Classes K, E1, E2, E3, E4, E5, F, L, D.
E: Engines Classes A1, B2, B3.
F and G: Engines Class D3 and Ashland Div. K5.
H: Engines Classes A2, A3, B1, F1.
J: Ashland Div. engines Classes K1, K2, K3, K4, N, N1.
K: Classes A4, C2.
L: Classes A5, C4, D1.
M: Classes C3, C5.
N and O: Classes B4, C6, D1a, D1b, D2a, D14 and Ashland Div. 14.
P: Class S3.
Q and R: Classes A, C, D12, S5, S7 and Ashland Div. I1 and I2.
S: Classes S1, D13.
T: Classes S4, S6.
U: Classes B and S2.
V: Classes D12a and Q.
W: Class D.
X: R 19½ x 26 (?)
Y: R 20 x 26.

Diagram No. 8.—C. & N. W. Railway Locomotive Lading.

The vertical scale represents tonnage, four spaces to the one hundred tons. The diagonal lines represent the relative tonnage of each class of engine to that of Class R, which is the uppermost line.

To find the tonnage for any class of engine over a certain piece of road get the Class R rating for that section from the published rating on time card and follow down the nearest vertical line until it intersects the desired class line, and take the reading on the vertical scale.

For Example.—If the Class R engines are rated 1,450 tons over a certain division, Class Q should be given 1,165 tons.

grade less than the ruling grade. Diagram No. 9 has been calculated for the standard Class R engine by using the data in Diagram No. 1 for the T of the locomotive, and the train resistance from Diagram No. 2. For example, it was found above that 1,750 tons was the "dead pull" limit for a 21-ft. grade. This would be at a speed of about 5 miles an hour. If, however, it be desired to maintain a speed of 20 miles an hour on this grade the load must be reduced to 900 tons, as will be found from the intersection of the 20-mile curve with the 21-ft. grade line. Or, on the other hand, the 1,750 tons could be hauled on a 5-ft. grade at 20 miles an hour. As previously explained, these curves will be approximately correct only for locomotives having about the same cylinder and boiler ratio as the Class R engine.

SUBJECTS FOR INVESTIGATION AND REPORT AT THE CONVENTION OF 1902.

Committee—S. Higgins, W. A. Nettleton, A. E. Mitchell.

No. 1.—Standard pipe fittings.

This committee to be appointed in conjunction with a similar committee of the American Railway Master Mechanics' Association, to consider report of the Committee of the American Society of Mechanical Engineers. Mr. B. Haskell, chairman, W. H. Lewis and Thos. Fildes.

No. 2.—Progress made and the present state of the art in improved methods of car lighting. C. A. Schroyer, chairman, L. T. Canfield, A. E. Mitchell, R. P. C. Sanderson and S. P. Bush.

No. 3.—Best methods in shop practice in meeting the requirements for the maintenance of all steel cars. Probable future shop changes necessary. W. H. Lewis, chairman, L. H. Turner, E. B. Gilbert, J. N. Barr and S. Higgins.

No. 4.—White pine and its substitutes in wooden car construction. W. E. Symons, chairman, J. J. Hennessey, A. Childs, H. J. Small and W. P. Appleyard.

No. 5.—Light weighing and stenciling of cars. F. A. Delano, chairman, D. F. Crawford and W. E. Symons.

No. 6.—Should the present cast iron wheel be changed in any manner to suit the 100,000-lb. capacity cars?

It is suggested that this committee consist of Mr. A. S. Vogt, chairman, C. M. Mendenhall and W. S. Morris. In case the Convention or Executive Committee should decide that this subject be referred to the Committee on Cast Iron Wheels, the Committee on Subjects would recommend as follows:

Substitute for No. 6. Suggestions on improved car construction gleaned from the Pan-American Exposition.

It is proposed that Mr. H. F. Ball, Mechanical Engineer of the L. S. & M. S. Railway, prepare this paper.

THE ESTABLISHMENT OF A JOINT LIBRARY IN CONNECTION WITH THE MASTER CAR BUILDERS' ASSOCIATION.

Committee—A. M. Waitt.

The matter has been carefully canvassed from the standpoint of both Associations, and as a result of the joint deliberations would report that it is deemed inexpedient at the present time to establish a joint library: First. Owing to the expense involved. Second. In all large cities excellent reference libraries are maintained, whose facilities are available to all. Third. There are comparatively few of our members who would be likely to avail themselves of such a library if established.

TESTS OF M. C. B. COUPLERS.

Committee—W. W. Atterbury, W. S. Morris, W. P. Appleyard, H. Monkhouse, F. A. Delano.

As a result of the experience that we have had during the past year, changes of considerable importance have been found necessary in the specifications of M. C. B. couplers, and minor changes have been thought advisable in the drop testing machine and the coupler contour gage. No changes have been found necessary in either the worn coupler gage or the twist gage, except to make the latter adaptable to the new design of coupler with increased shank.

Specifications.—The specifications in their present form have not proved as commercially practicable as is considered advisable, due partially to their lack of definiteness and to their severity, and also because there are certain portions of the specifications which, in the judgment of the committee, are unnecessary. The modifications to which the committee particularly calls attention are: First, the requirements of the specifications have been made uniform for couplers, whether of cast steel or malleable iron; second, the abandonment of the separate knuckle test. An extended experience with the M. C. B. testing machine has forcibly impressed on the committee the advantages of good, well-annealed cast steel as a material from which to make the body of the coupler; so much so that in its judgment it is inadvisable to longer retain in the specifications any preferential test for any other material. The separate knuckle test, in connection with the test of couplers is an unnecessary expense, as the knuckles are already thoroughly tested in tests 1, 3 and 4.

Drop Testing Machine.—On account of the change in the design of the standard shank, it was found necessary to widen out the sides which hold the shank in place, as well as to accommodate butts of larger dimensions than the standard.

It was also found advisable to raise the sides from 17½ ins. to 19½ ins. on account of the severity of the test with the former height.

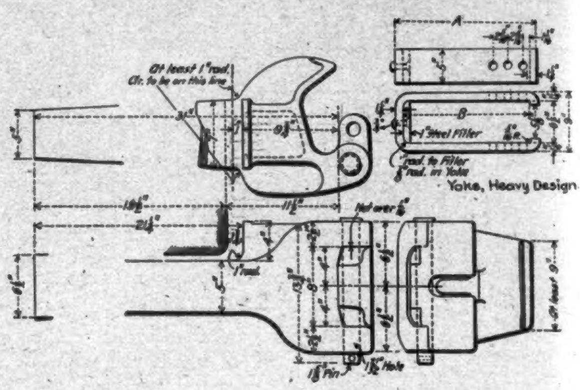
Coupler Labels.—Experience has demonstrated the impossibility of successfully casting in steel a legible label of the present dimensions, and while ½-in. letters might be used to replace the 5/16-in. size, a simpler arrangement, similar to that used on wheels, is preferable. The label now recommended has been incorporated as a part of M. C. B. sheet "K."

Coupler Contour Gage.—With the new design coupler contour gage it was found that through the carelessness or captiousness of an inspector, a coupler could be condemned which was really within the prescribed limits. The contour between the theoretically correct and the inferior limit allowable permits so much play between the gage and the coupler head, that the guard arm gaging screw can be made to fall beyond the end of guard arm, even though the latter may be of the proper length. This screw can then be moved to the condemning position without touching the coupler. To prevent this, and to secure approximate coincidence of center lines of coupler head and gage, a spring socket and contact has been added.

Worn Coupler Gage.—There has been some criticism of an indefinite character by some members of the association, against the use of this gage. The committee realizing the importance of this gage, both in its use and abuse, has had the matter particularly followed up, and as a result of a year's experience, is satisfied that no change at the present time is necessary or advisable. The committee would strongly recommend that the worn coupler gage be put in general use at repair shops and repair tracks. While this will result in the condemnation of a great many knuckle pins, locks and knuckles, it will not affect a very large number of couplers. The couplers in almost all cases are brought back to gage by the replacement of the knuckle, knuckle pin or the lock, and such couplers as are condemned will be of the short-arm type or of the long guard arm, in the event of the guard arm being seriously damaged. It is the opinion of the committee that this gage should not be used at interchange points, as, for transportation reasons, it is impracticable, its use necessitating the separation of the cars. If the various roads in the Master Car Builders' Association would conscientiously put this gage in use in the manner outlined by the committee, the general condition of the couplers throughout the country would be decidedly improved, but in so gradual a manner as to work no great hardship on the car owner.

Twist Gage.—On account of the proposed changes in the shank of coupler, it has been necessary to alter the design of the twist gage so as to be applicable to 5 x 5-in. or 5 x 7-in. shanks. Also so that it can be used with butts of even larger dimensions than those of the association.

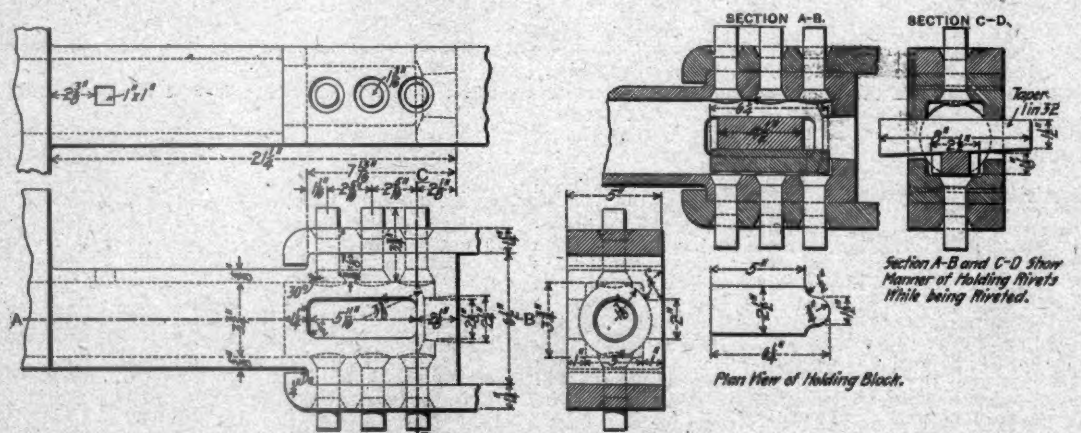
Link Pin Holes and Link Locks.—The committee had hoped to have been able to present, at the present meeting, a means by which cars could be handled around curves, or on and off floats, without the use of link and pins, thus being able to abandon the link pin hole and slot in the knuckle. It has experimented with several designs of its own, as well as with some patented appliances, but as yet has not been able to find anything that successfully met all the requirements of the service. It was thought that the dimensions of the link slot might be reduced, but this has been found impracticable where floats are used, and particularly so at tide water. It is, therefore the opinion of the committee that no change should be made at the present time.



Automatic Coupler 5-in. x 7-in. Shank and Increased Head.

Proposed Heavy Coupler and Yoke.

Increased Dimensions of Coupler Body.—Since the last meeting of the association the committee has experimented very largely with couplers with increased shank and now presents a design of shank 5 x 7 ins. back of the head, with the larger dimension in horizontal plane, as its recommendation as standard of the assoication. This recommendation is made after serious consideration of the changes that will be necessitated in the various parts affected, but a change must be made to get increased strength, and the proposed change gives us this increased strength with the least additional material, and less seriously affects the related parts than would the change to a 6 x 6-in. The committee, as a result of the guard arm tests of 179, 5 x 7-in. shanks and 58, 5 x 5-in. shanks, has found that the increase in strength is as the ratio of 23 to 13, or a gain of 76 per cent. Experience also shows us that an increase in the dimensions of the head of the coupler is necessary, and this fortunately the committee can give, without seriously affecting any of the working parts of the car. The dimensions 8¾ ins. from the back of the lug to the inside face of the knuckle should be increased to 9¾ ins., thus allowing an increase of 1 in. or more in metal through all parts of the head. The vertical dimensions of the knuckle through the knuckle pin hole have been increased to 8 ins., and of the lugs to 2½ ins., thus materially increasing the strength of all the parts. During the coming year the committee hopes to experiment with a head of these dimensions, and at the next meeting of the asso-



Proposed Butt for 5 x 7 in. Shank.

ciation will be prepared to give some definite figures as to its relative strength.

Increased Butt.—At the request of the Committee on Draft Gear we have seriously considered a redesign of the standard butt, retainng the present dimension of 6½ ins. as its depth, lengthening the butt so as to allow the use of a third rivet or bolt. The dimensions between the back of the butt and back of the horn have been retained as at present. The committee submits a proposed arrangement for the consideration of the association. We have always recognized the impossibility of properly riveting the yoke to the butt because of its inability to hold the rivet. The committee, therefore, in its proposed arrangement has entirely departed from the old design, and suggests an arrangement whereby the riveting can be successfully done. As the design is quite a radical departure from anything that has heretofore been used, the committee is not prepared to recommend the arrangement as standard until after a series of experiments which are being conducted has proven the correctness of the design.

Heavy Design Yoke.—The committee has prepared a design of yoke with the strength increased to correspond with that of the increased shank, and to be used in connection with the 5 x 7 shank coupler. For the coming year the committee has considerable work laid out. As previously explained, it will be necessary to experiment with the new design of head, as well as that of the proposed butt. In addition, proper gages for the butt will have to be developed, on account of the necessity for uniformity of dimensions at all points. The abandonment of the separate knuckle test in the regular specification leaves the association without a test for knuckles which may be purchased separately for repairs. The separate knuckle test has never been other than a rough test of the quality of the material. The committee is working on a method whereby knuckles can be tested with a dummy coupler, somewhat as are the knuckles in a complete coupler test at the present time. The committee has also felt for some time that the jerk test might be improved upon by introducing the impact arrangement as exemplified in the method at Purdue University, and recommended by Prof. Goss for the impact testing of material. If successful, this would make unnecessary the use of two couplers in the jerk tests, a dummy being substituted in the impact test for the second coupler.

MAXIMUM MONTHLY MILEAGE IT IS PRACTICABLE AND ADVISABLE TO MAKE; HOW BEST TO MAKE IT, BOTH IN PASSENGER AND FREIGHT SERVICE.

Committee—T. H. Symington, Mord Roberts, Geo. F. Wilson.

It is generally accepted that there is no limit to the monthly mileage it is advisable to make, consistent with proper maintenance of the power and sufficient rest for the enginemen.

It is frequently stated by practical railroad men that engines need a rest after each trip. This is not the case, as the boiler (which is the backbone or keystone of the whole machine) is more damaged by periodic contraction when cooled and expansion when heated, than by continuing to do its duty in making steam.

By getting the maximum possible mileage out of power, fewer engines are needed and a great saving is made in outlay for equipment; or, expressed differently, a locomotive is good for a certain fixed number of ton-miles and to get this return in ten years is better policy than to wait for twenty-five years. It is best to get the full service from our engines quickly so they can be replaced with more modern power. We therefore believe beyond question that the maximum mileage it is advisable to make is only limited by what is practicable.

It is impossible to theorize on the maximum mileage to be obtained on various roads, as we have all been figuring over the problem for years with very different results. The best practice as reported by thirty separate lines is given in the table below, and we can simply take these results as a high standard and endeavor to follow and improve on them.

The Best Reported Practice on Different Length Divisions.

Division.	Service.	Monthly mileage.	How engines are crewed.	Lay-overs at terminals. Home. Hours.	Other. Hours.
100 miles	Passenger	7,000	Double with extra men...	30	6
100 miles	Freight	5,500	Double	8	5
125 miles	Passenger	8,300	Pooled	8	5
125 miles	Freight	6,900	Double with extra men...	9	4
150 miles	Passenger	9,000	Double with extra men...	10	4
150 miles	Freight	6,500	Double with extra men...	6	3
175 miles	Passenger	10,000	Double	32	4
175 miles	Freight	6,600	Double	10	6
200 miles	Passenger	10,500	Pooled	20	5
200 miles	Freight	6,500	Pooled	8	8

That it would be possible to improve on these results under special conditions is indicated by the fact that the average of replies from all thirty lines gives 7 hours for passenger and 6½ hours for freight as the necessary lay-over at the home terminal to properly care for the engines. The lay-over at the other terminals can theoretically be much less.

It is often possible to lengthen out divisions, and the table below indicates the great advantage of doing so. This table shows an average of practice, and each road is given the same value regardless of the number of engines on its several divisions.

Average Monthly Mileage Made on Different Length Divisions.

Service.	100-mile.	125-mile.	150-mile.	175-mile.	200-mile.
Passenger	5,067	5,605	6,487	7,071	7,331
Freight	3,720	4,258	4,416	4,758	5,125

It will be noted that the average of thirty roads would indicate that engine mileage can be increased in both passenger and freight service, in about the same proportion as divisions are lengthened from 100 to 200 miles. For various practical reasons your committee would recommend that all divisions be lengthened so that the average service will consume from eight to ten hours between terminals.

The effect of grades and curves in reducing the speed of maximum trains, and consequent lengthening of the time between terminals, greatly reduces the monthly engine mileage, and probably more money has been spent on straightening curves and reducing grades, in the last ten years than on any other improvements. It is sometimes the case that a great deal of time is necessary to get trains over a maximum grade, and the time would be greatly shortened by putting helpers at these points.

As a rule, schedules are made with reference to connections and markets, but it is frequently the case that they may be changed to better suit the motive power requirements.

The average lay-over at the home and other terminal is given in the table below as reported for thirty roads, each road being given equal value in the averages, regardless of the number of engines in service.

Average Lay-over at Home Terminal on Different Length Divisions.

Service.	100-mile. Hours.	125-mile. Hours.	150-mile. Hours.	175-mile. Hours.	200-mile. Hours.	Average. Hours.
Passenger	13	14	16	18	22	16.6
Freight	12.5	12.5	14.5	10.5	19	13.8

Average Lay-over at Other Terminals on Different Length Divisions.

Service.	100-mile. Hours.	125-mile. Hours.	150-mile. Hours.	175-mile. Hours.	200-mile. Hours.	Average. Hours.
Passenger	6	7	9	8	14	8.8
Freight	7	9	9	8.5	9	8.5

It will be noted that the average lay-over away from the home terminal is over eight hours for both passenger and freight engines. The reasons for this are many. It is seldom that the traffic is balanced in both directions on a division; sometimes the light mileage is in one direction and sometimes in another, and the transportation department usually prefers to have the balance of power at that end from which the business starts. Another cause of unnecessary lay-over away from the home terminal is that crews, on single crewed engines, frequently have their homes at that end of the division. We would recommend that our transportation departments arrange as far as practicable for a minimum lay-over away from the home terminal, and that crews be required to live at the point most conducive to economy of operation.

On most roads there are certain seasons when the power is taxed to its utmost, and others when engines must be laid up. When the heavy season is a short one, it would, of course, be desirable that in this season every effort be made by the transportation department to arrange especially for an absolute maximum of mileage temporarily, even though at some sacrifice to other requirements, and to the comfort or custom of the crews.

It is wonderful the increased results that are obtained sometimes by a young and inexperienced runner over an older man, because the younger man will try to get everything out of the engine that is in it. This policy will undoubtedly avoid the purchase of many locomotives, and thereby increase the mileage and revenue from what we have the balance of the year.

The tables below give the average mileage for different methods of crewing on different length divisions as reported by thirty separate roads, equal value being given to each line regardless of the number of engines in service.

Average Mileage in Passenger Service for Different Methods of Crewing on Different Length Divisions.

Method of crewing.	100-mile Div'n.	125-mile Div'n.	150-mile Div'n.	175-mile Div'n.	200-mile Div'n.	Average.
Single	4,066	3,980	4,276	3,983	4,000	4,051
Single with extra men	4,700	5,400	5,450	7,850	.....	5,850
Double	5,500	6,626	8,300	9,066	8,150	7,528
Double with extra men	6,045	.....	9,000	9,000	.....	8,015
Pooled	6,000	5,500	8,000	.....	9,250	7,187

Average Mileage in Freight Service for Different Methods of Crewing on Different Legnth Divisions.

Method of crewing.	100-mile Div'n.	125-mile Div'n.	150-mile Div'n.	175-mile Div'n.	200-mile Div'n.	Average.
Single	3,274	3,480	3,600	4,108	4,000	3,567
Single with extra men	4,425	4,500	4,200	.....	5,000	4,450
Double	4,325	6,900	5,450	.....	8,150	4,891
Double with extra men	.....	.....	5,700	.....	.....	5,900
Pooled	3,800	3,959	4,337	4,900	6,500	4,527

Special attention is called to the average mileage on all divisions in both passenger and freight service, as reported by thirty separate roads and representing their best practice. It will be noted that the mileage increased regularly in the following order of crewing:

1. Single. 2. Single with extra men. 3. Pooled. 4. Double. 5. Double with extra men.

The only way in the control of the machinery department to increase an engine's mileage is to reduce the necessary lay-over at terminals to a minimum.

An average of replies from thirty separate lines gives 4,650 miles in passenger service and 3,550 miles in freight service as

the monthly maximum it is considered enginemen should be allowed to make. On the other hand an average of the same replies gives 4,250 miles in passenger service and 3,330 miles in freight service as the monthly mileage men are satisfied to make. Under normal conditions it would then seem that two men by continuous running can make regularly almost as great a monthly mileage together as is practicable for one engine.

On account of the great variation in the amount of business at different seasons on most lines, the ideal arrangement of crews would be to have a flexible system arranged to the best advantage for normal service, but capable of expansion or contraction without hardship or loss of money to the older employees.

Pooling is flexible enough, but it puts all men on exactly the same plane and they fare alike. The old experienced runner is on the same footing with new men in the same pool. Of course when the pool is contracted, the younger men are dropped out, but there are often intervening periods when the pool is kept full of men without enough work for them all. On roads where it is only practicable to make a low monthly engine mileage except during one or two very short heavy seasons, we would strongly recommend that the engines be regularly single crewed and special arrangements made during the short heavy seasons.

The most flexible arrangement of crewing with consideration for the old and more competent runners would seem as follows, for a road with varying traffic: First condition, normal, single crew. Second condition, single crew and extra men. Third condition, double crew. Fourth condition, double crew and extra men.

For a road with more regular traffic: First condition, normal, double crew. Second condition, double crew with extra men.

No one denies that where one or two men are regularly assigned to an engine, it gets more careful and systematic inspection by the enginemen, and as a rule is kept in better condition than when the engine is pooled. This is natural, as the best roundhouse practice consists in correcting little troubles before they are apparent to the inspector's eye, and human nature will not permit a runner on a pooled engine to take the pains to investigate and locate incipient troubles as if he had a personal interest in his machine. Single crewing undoubtedly provides best for the care of locomotives, but they will be very well looked after if two men are equally responsible.

For large monthly engine mileage, the roundhouse and its methods are perhaps the largest single factors in the entire question. Practically the entire function of the roundhouse, aside from hostlering the engines, is to take the stitch in time that saves ninety-nine. The talent required to properly look after engines there is of a higher order than that needed in the back shop. Any mechanic can tell what is the matter with a driving box if it is out on the floor, but it takes more ability to locate a pound on an engine in the roundhouse, and find out which box is going to give trouble. We frequently see roundhouses insufficiently equipped with men and appliances for the proper handling of the work. It is the roundhouse that keeps engines in service, and we believe it is far better to thoroughly equip it with the best men and tools, before giving any serious consideration to the balance of the locomotive plant.

We believe that a thoroughly up-to-date roundhouse foreman, who has competent men under him, and who knows in detail, himself, the condition of every engine in his division, who can keep his work behind him and not ahead of him, has more to do with keeping engines in service than any man in the machinery department. He must be backed up, and when curtailments of force are necessary, his force should be the last to suffer.

Summarizing our conclusions, we recommend, for a maximum monthly engine mileage, as follows:

That short divisions be lengthened so that the average service will consume from eight to ten hours over the division one way. That there be as low a maximum grade and degree of curve as practicable, and that helping engines be placed at one or two points on a division where the grade is considerably in excess of the rest of the division. That unnecessary stops be eliminated as far as practicable by the better location of water columns.

That as far as practicable schedules be arranged to give reduced lay-over away from the home terminal. That crews be required, as far as practicable, to live at the point most conducive to economy of operation, and to keeping engines in service. That transportation officers avoid the demand for more power when during a short heavy season some other requirements of the service can be adjusted temporarily, thus avoiding the laying up of engines in normal season. That transportation officers do not make the demand for all engines to be in good order, resulting sometimes in the purchase of new power for heavy seasons, when it might be avoided, and thus provide for increased mileage in normal seasons.

That engines be double-crewed with extra men for relief when there is enough work on one engine for two men. When this is not the case, that they be single-crewed with extra men for relief. That special attention be given to the roundhouse force and equipment, and that it be the last place to suffer from reduction of force. That the very best talent in the machinery department be placed in charge of the roundhouse work, and that system alone be not depended on for results. That the inspection of engines be reported separately by the enginemen and inspectors, as a check on their attention to detail. That the roundhouse work be specialized as far as possible, so as to avoid a division or uncertainty of responsibility. That the existing methods be overhauled so that necessary routine work will not cause engines to lose their turn. That with the change to the pooling system, adequate preparation be made for more careful inspection, and heavier charges to maintenance. That interchangeability of parts be adhered to as far as practicable in various types of engines. That we strive after simplicity of design, and adhere to what we know is all right, unless there are excellent reasons for change.

LABORATORY TESTS OF BRAKE SHOES.

Committee—S. P. Bush, R. P. C. Sanderson, Geo. Gibbs.

The last report of the committee which contained the results of tests made was presented in 1896; since that time the committee has had no report to make, except that of last year on the installation of the testing apparatus at Purdue University, and the arrangement effected between the Master Car Builders' Association and the Purdue University concerning its care and use.

At the last convention the committee was instructed; first, to make tests of any brake shoes that might be submitted to it by any railroad company belonging to the association; second, to present a specification for adoption as standard by the association which would cover the essential and most desirable features of a satisfactory brake shoe for steam railway purposes.

In compliance with the above, the committee, through the secretary of the association, gave due notice to all concerned that it would receive brake shoes for test. Arrangements were also made with Professor Goss whereby, under the direction of Professor Smart, the work of testing would be conducted in a manner exactly similar to that followed in 1896, it having been demonstrated by the committee and the university authorities

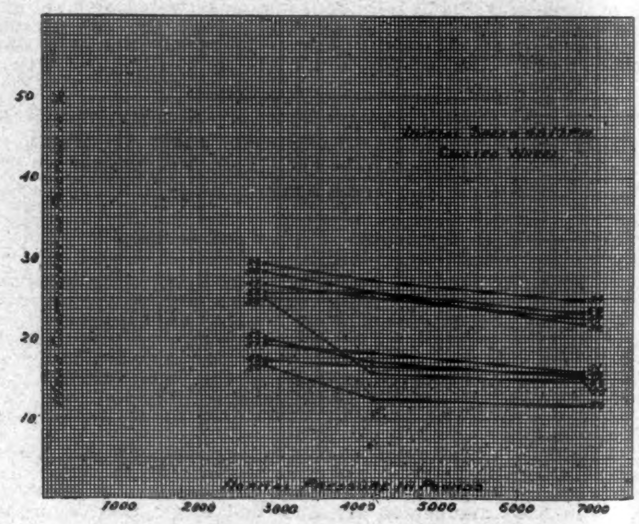


Diagram B.—Graphical Summary and Comparison.

who have used the machine frequently that the original results obtained by the committee were both accurate and reliable, and as representative as possible of actual conditions.

The shoes submitted for test and tested were as follows, the number opposite each one being the laboratory number and the number by which each shoe is designated:

Shoe.	Laboratory Number.
Lappin	47
Sargent U (Broke)	48
Streeter	49
Corning	50
Herron	51
Cardwell	52
Ideal	53
Cardwell	54
Sargent U	55
Composite	56
Diamond S	57
Diamond S	58

Note.—Tests of Diamond S shoes could not be completed in time for printing, but will be presented at the convention.

The data in detail is shown by the tabulated statements and diagrams. The result of each, as compared with the "A" or soft cast-iron shoe originally tested by the committee, is shown by the graphical diagrams on which the solid line indicates the "A" shoe and the dotted lines the shoe indicated by the number on the margin.

It is apparent that the shoes producing the greater friction also show the greater wear, and the committee feel safe in stating that this is the general rule, which may, however, have some exceptions, and may show differences in the amount of wear for any given friction. An examination of the particles

worn from each shoe, and samples of the fractured shoes themselves, will give anyone an idea as to the causes that have produced the results in each specific case.

The committee has no knowledge as to the origin of the shoes tested, and desires to state distinctly that all brake shoes furnished under similar names may not give the same results as those tested. The committee recommends that the results shown should be regarded more as an indication of what it is possible and practicable for brake shoes made up under the various forms to produce, and that anyone desiring to be assured of getting brake shoes with a specific value as to friction, can only do so by selecting samples from time to time and having them tested, or by learning the physical qualities as developed by the character of the fracture, or by having satisfactory samples of fractured shoes with which to compare.

As to the matter of presenting a specification, it may be stated that a perfect specification should cover:

1. The mean coefficient of friction throughout the length of the stop.
2. The final coefficient of friction which is taken at a point 15 ft. from the end of the stop.
3. The initial coefficient of friction which is taken to be the highest value obtainable at a point near the beginning of the stop.

Such a specification, however, would perhaps be unnecessarily refined and complicated for practical purposes, and it seems

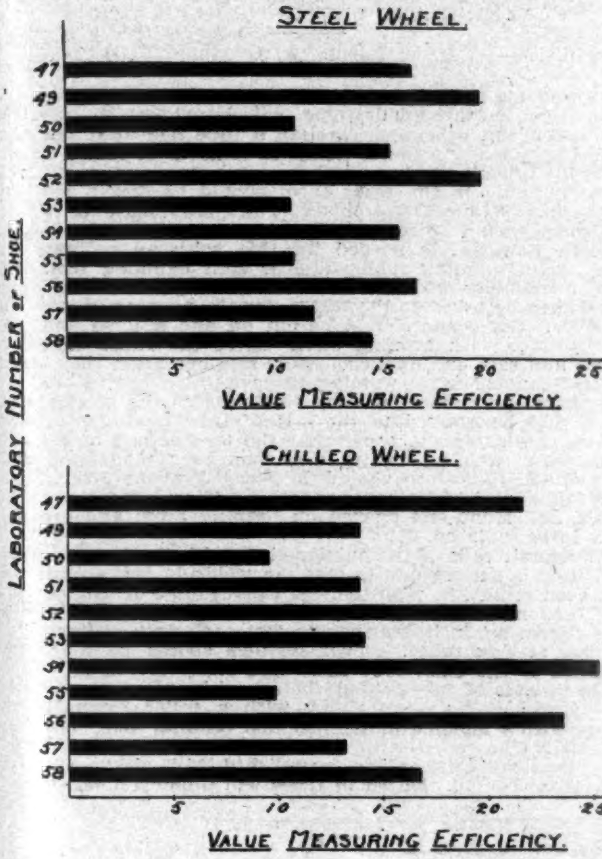


DIAGRAM C.

probable that the several factors are so related that a specification covering one or two would insure protection against failure in respect to others.

The committee is of the opinion that, to cover the frictional clause satisfactorily it will only be necessary to use two of the factors, i.e.: the mean coefficient of friction for the whole stop, and the final coefficient of friction.

The committee is also of the opinion from a review of all the data obtained from the test of the machine, that these results are more satisfactory for purposes of comparison when stops are made from a speed of forty miles per hour, and for this reason it is proposed to make this the standard speed in the proposed specification, and follow the original practice of the committee in adopting three comparative pressures, i.e.: 2,808 lbs., 4,152 lbs. and 6,840 lbs., respectively.

Considering the question as to whether it would be desirable to have a separate specification for chilled and steel-tired wheels, the committee, after reviewing the results, does not feel that such would be warranted. The results indicate plainly that a satisfactory friction can be obtained on either, although as a rule the coefficient of friction obtained on steel-tired wheels is somewhat lower than on the chilled, but inasmuch as the steel-tired wheels are used principally in passenger service, the committee is of the opinion that an effort should be made to keep the coefficient of friction up with a view of keeping the efficiency of the brakes up to a proper point. The committee, therefore, proposes the following specification for a brake shoe having the standard M. C. B. dimensions:

Specification.

Shoes when tested on the Master Car Builders' testing machine in effecting stops from an initial speed of forty miles an hour shall develop upon a cast-iron chilled wheel, or upon a steel-tired wheel, a mean coefficient of friction of not less than:

25 per cent. when the brake shoe pressure is 2,808 lbs.
22½ per cent. when the brake shoe pressure is 4,152 lbs.
20 per cent. when the brake shoe pressure is 6,840 lbs.

The rise in the value of the coefficient of friction at the end of the stop shall be within such limits that the value of the coefficient of friction for a point of 15 ft. from the end of the stop

TABLE I.

Shoe.	Lab. Number.	Wheel.	Coeff. of Friction in Per Cent. Mean—A.	Final—B.
Lappin	47	Steel	20.45	28.37
		Chilled	24.87	31.26
Streeter	49	Steel	21.90	26.55
		Chilled	16.51	21.76
Corning	50	Steel	14.22	20.88
		Chilled	13.69	22.00
Herron	51	Steel	18.98	26.03
		Chilled	17.80	25.66
Cardwell	52	Steel	22.91	29.29
		Chilled	24.42	30.64
Ideal	53	Steel	14.13	21.05
		Chilled	17.46	24.36
Cardwell	54	Steel	18.72	24.50
		Chilled	27.29	31.47
Sargent U	55	Steel	16.78	28.74
		Chilled	16.16	28.85
Composite	56	Steel	20.66	28.67
		Chilled	25.86	30.41
Diamond S	57	Steel	17.13	27.86
		Chilled	18.90	30.46
Diamond S	58	Steel	18.12	25.39
		Chilled	20.63	28.46

will not exceed the mean coefficient of friction by more than 7 per cent.

This specification is based upon the results obtained in the case of ordinary or reasonably hard cast iron, such as the "B" shoe of the original tests, and a good quality of composite shoe. It will be noticed that this specification does not place a maximum limit on the coefficient of friction. The committee has omitted this for the reason that it believes it is the desire of the association to encourage high frictional qualities as well as satisfactory wear. It is found that high and uniform frictional qualities are desirable in that it makes it possible to perform the operation of braking with an expenditure of less work and with lighter and less expensive brake gear. The committee believes that it is undesirable to use a brake shoe that gives a high coefficient of friction at or near the end of the stop, as this results in sliding the wheels, and in recommending that the coefficient of friction for a point 15 ft. from the end of the stop should not exceed the mean coefficient of friction by more than 7 per cent., it was intended to exclude only the worst of those that have been presented for test.

Finally, it may be stated that as development in the matter of brake shoes continues, it may be found desirable to make some modification in the specification proposed, but for the conditions existing to-day, the committee believes that it is fair and reasonable, and urges all members to pay some heed to the frctional qualities of brake shoes that they may use.

THE CHEMICAL COMPOSITION OF ALL STEEL CAR AXLES.

Committee—E. D. Nelson, C. A. Schroyer, F. A. Delano.

At the convention held in Saratoga, N. Y., in June, 1900, the question of changing the chemical composition of steel car axles, as outlined in the M. C. B. specifications, was discussed. The point made in the informal discussion held at that time was that the present specifications provided too high a proportion of carbon.

The first work of your committee was to correspond with those who had taken part in this discussion, and ascertain if possible their reasons for wishing to decrease the percentage of carbon. The result of this correspondence was that a number of instances where steel car axles had broken, were cited to your committee, with the statement that such axles had been bought in accordance with M. C. B. specifications for steel axles, at least in relation to the percentage of carbon contained in the steel. Your committee was particular to trace out these cases of reputed broken axles, and found that, although the information given was in entire good faith, a careful investigation showed quite clearly that the axles in question which had broken were not known absolutely to have been made in accordance with the chemical compositions required by the M. C. B. specifications; in fact, it was quite clear that these axles either were not bought under these or similar specifications, or else, if they were, no means had been taken to see that the axles furnished were strictly in accordance therewith. It is therefore clear to your committee that so far as these cases of broken axles are concerned, they do not furnish any evidence that the percentage of carbon allowed in the present specifications is too high. In addition to the above investigation, your committee has been in correspondence with railroad companies who have specifications for steel axles, or who have used the present M. C. B. specifications, and the matter seems to stand, so far as the opinion of those in charge of the car departments

on these railroads is concerned, that the percentage of carbon now allowed is not too high, and it is even intimated in some instances that if any change is made it should be in the direction of higher carbon.

Your committee does not feel justified in recommending any increase in the percentage of carbon above that allowed at the present time, but is strongly of the opinion that no decrease should be made and urges that the specifications in regard to chemical composition shall remain as at present. In connection with this subject, your committee desires to offer some suggestions having a bearing on the subject of the specifications.

First. As to the location of the boring to be taken from steel axles for chemical analysis. This should be distinctly defined by

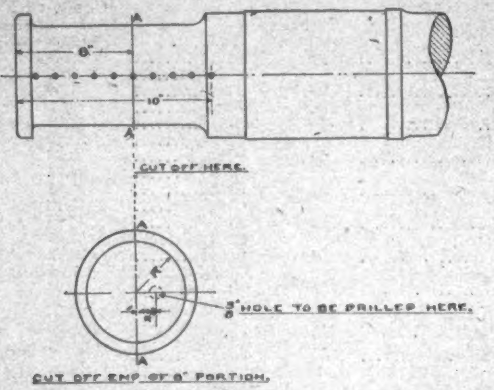


Fig. 1.

a diagram as shown in Fig. 1, attached to this report, and your committee would recommend that this be incorporated with the specifications.

Second. The present M. C. B. axles, except of the later design, have not had their dimensions determined upon the basis of uniform fiber stress between the center and the hub portion of the axle. In order to have uniform fiber stress throughout the body of the axle, it is absolutely necessary that the taper between the wheels should be straight and uniform. It has been found that some manufacturers neglect this, possibly due to a misunderstanding of the importance of this point, and your committee would recommend that a notation to this effect be placed on the standard drawing of M. C. B. axles as shown in Fig. 2.

Third. It is further thought by your committee that the question of having all steel axles rough turned should be seriously considered. Provision for this is now included in the M. C. B. specifications, but your committee thinks that sufficient emphasis is not placed on this matter by members of the association ordering steel axles. There is a decided advantage to the railroad companies in getting steel axles turned throughout their length, because it enables the inspector to determine readily whether the dimensions and contour required are strictly followed. It is thought no great opposition will be made to this practice, as the principal manufacturers are equipped for doing this work.

Fourth. M. C. B. axle "A," having journals 3¾ by 7 inches, is somewhat small at the wheel seat acording to the method folfowed for the design of axles "C" and "D." The wheel seat of axle "A" shrould have a limiting diameter of 4⅞ ins., and allowing ¼ in. to be turned off, the original size should be 5⅛ ins. As this axle, however, was designed for cars of 40,000 lbs. capacity, it may not be considered advisable by the association to make any changes in its design.

Fifth. Axle "B," having journals 4¼ by 8 ins., now has a wheel seat 5⅝ ins. in diameter. The limiting size of wheel seat for this axle should be 5½ ins., and allowing ¼ in. to be turned off, the original size should be 5¾ ins. The center of this axle is now 4⅝ ins., and your committee would recommend that it be made 4¾ ins., in order that it shall have the same fiber stress as used in axles "C" and "D." The height of drop in the present specifications for this axle is 34 ft. This is incorrect for the axle having a center of 4⅝ ins., but would be correct for this axle having a center of 4¾ ins. Therefore, the change recommended will make the size of axle consistent with the specifications, besides reducing the fiber stress, which is now somewhat greater than in the axles of later and more approved design.

Sixth. Axle "C," having journals 5 by 9 ins., now has a wheel seat 6⅜ ins. As the limiting size is 6¼ ins., it is thought that the new size should be 6½ ins., leaving the axle otherwise unchanged.

Seventh. Axle "D," havng journals 5½ by 10 ins., now has a wheel seat 6⅞ ins. As the limiting size is 6¾ ins., it is thought that the new size should be 7 ins.

Eighth. In accordance with the designated standards of the association, axles "A" and "B" are specified for use under cars of 40,000 and 60,000 pounds capacity. It is only necessary to remind you of the fact that an axle is designated for carrying a definite weight to make it plain that the axles of the association should not be designated for cars of particular capacity. This is at once apparent when it is considered that under this assumption no consideration is given to the weght of the body of the car, which varies through wide limits. This is, of course, a portion of the weight carried, and together with the lading makes up the total weight carried on the car axles. Therefore, your committee would ask your consideration for a better designation of these axles, which would be as follows:

Axle "A," designed to carry 15,000 lbs. Axle "B," designed to carry 22,000 lbs. Axle "C," designed to carry 31,000 lbs. Axle "D," designed to carry 38,000 lbs.

Ninth. In conclusion, your committee feel that they should call the attention of members of the association to the desirability of ordering their axles according to the M. C. B. specifications. There are a number of railroad companies ordering steel axles and having specifications varying slightly from those of the association. It would appear to be to the advantage both of the manufacturers and of the railroad companies, to have these specifications uniform, and your committee would urge serious consideration of this question.

THE MOST SATISFACTORY METHOD OF HANDLING, CLEANING AND SETTING BOILER TUBES.

Committee—W. H. V. Rosing, A. E. Miller, C. H. Doebler.

Tubes should be cut out of both tube sheets with a power cutter and removed through dry pipe holes providing the pipe has been taken out, otherwise through a tube hole that has been reamed sufficiently large to admit of removal of tubes, according to the probable amount of hard scale they may carry. The ends remaining in the front sheet should be driven out with a pneumatic hammer and chisel. The ends remaining in back tube sheet should be removed in a similar manner. A heavier hammer, however, is needed for this, with an ordinary flat chisel about one-half inch wide, or split caulking tool. The labor of chipping off beads can be then dispensed with. They should then be taken to the rattler for the purpose of removing the scale. Safe ends should be cut off and scarfed and piled near furnace with horning anvil where the tubes should be opened and safe end applied. After this operation they should be piled convenient to welding furnace.

The safe end should be same thickness as the original tube and should be applied to the end of tube having previously received a safe end in order that the thicker end of the tube be used for welding. After weld has been made and scale scraped off, the tubes should be swaged about 5-32 in. and stood up in quicklime for annealing. They are then cut to length, and front end opened on horning anvil and are then ready to be replaced.

The committee is of the opinion that, with the average workman, it is not necessary to test the welds in tubes until they have been reset, for, with the small percentage of failures, it is more economical to remove a defective tube occasionally after having been set in boiler than to test each tube separately.

Before setting tubes, copper ferrules should be rolled into the holes of the back tube sheet and tubes driven into them. The back ends of tubes should be set with a Prosser expander and after peening over, rolled with a roller expander and beaded with a pneumatic hammer and beading tool. The front ends should be rolled with a roller expander.

The heating of tubes is accomplished with either coke, anthracite coal or oil. Either of these will produce a satisfactory welding heat and the furnace should be arranged for heating as many tubes simultaneously as the man at the welding machine can handle without waiting for a heat. The fuel used is rather a matter of cost, according to local conditions, than of specific kind.

Where coal or coke is used it should be fed to the furnace by means of a hopper. In case of burning oil, it should be applied with a burner at both ends, especially where tubes are being heated from both sides of the furnace.

The committee recommends the scrapping weight of tubes for boilers carrying 200 lbs. boiler pressure as follows: 2-in. tubes, 1.65 lbs. per foot; 2¼-in. tubes, 1.85 lbs. per foot. From this it is obvious that a heavier tube will have a greater percentage of service metal.

No definite information was received regarding the merits of steel tubes as compared with charcoal-iron tubes. The experience with steel tubes seems to have been very limited. The opinion of the majority favored charcoal-iron tubes from the fact that they pitted less and would hold a better bead. The principal trouble, however, was in the welding of steel tubes to steel safe ends. The committee is not prepared to say how much of this is due to the inexperience of the operator or to the metal itself.

Fig. 2.